Vol. 32, No. 4 April, 1935

THE
PSYCHOLOGICAL BULLETIN

A SURVEY AND SYNTHESIS OF LEARNING THEORIES

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I

The most recent studies of learning, instead of converging toward some common envisagement of learning as a fundamental phenomenon, have tended rather toward ever sharper divergence. And it is a depressing thing to note the acrimony that is allowed to creep into what purport to be scientific discussions of natural science events, the acrimony varying pretty directly with the youthfulness of the schools represented, and taking its saddest form in a vituperative reading out of the field of learning any phenomena of change or improvement that fails to qualify by coinciding with a given school's favorite formulation. With a faith in the eventual congruence of natural phenomena, I propose that we scan the evidential bases claimed for the different doctrines of learning, to see whether there be not indeed more fundamental compatability and even agreement than ardent devotees of the "schools" would seem to realize.

For the present day commentator the manifold theories of learning naturally group themselves into three general types. Historically oldest is the English *trial-and-error* mode of description: its theoretical roots in writings of Bain, its pointed application by Lloyd Morgan, and its experimental verification in America by Thorndike. Historically next appeared the Russian contribution of the *conditioned-response* concept, growing out of physiological experiments of Pavlov and Bekhterev, and greatly elaborated by them, in which they were followed in America by Watson. More recently has come the German *Gestalt* doctrine, spreading from Wertheimer's work on perception to more definite applications to learning by Köhler. Cer-

tain other favorite viewpoints there are, claiming originality and inspiration; but they are, I believe, subsumable under one of those mentioned; *e.g.*, the varying emphases upon the "dynamic field", the "sudden insight", and the "purposive" characters are subsumable, without violence, under the third.

The suggestion I am making is that we set up tentatively some of the major *theoretical emphases of this or that of the three schools* just mentioned, and then canvass the experimental bases of all three to note whether such emphasized points may not actually *be found in the data of all*. For lack of space, my notes will have to consist of the barest of references, merely enough to help the reader to identify and recognize them, and they will in nearly all cases be only a few selected out of very many available ones. Where the experimental point involved may be expected to be well known, I assume that no explicit references are needed. I shall enunciate one principle at a time; and in connection with it I shall point out its appearance (in some degree) in *conditioned-response* experiments, then in *trial-and-error* experiments, and then in *Gestalt* experiments.

II

I. The Subject Must Be Motivated

Conditioned-Response Experiments. The response to which a new unconditioned stimulus is to be attached must be (to quote from Pavlov) "biologically of importance", "must have a high place in the hierarchy of reflexes"[1], *e.g.*, in his and in other experiments the subject must be hungry for success in conditioning the salivary response; the subject must be "alert" (Pavlov's word)[2]; hunger must be stronger than pain[3]; in Mrs. Jones' work, hunger had to be stronger than fear[4]; and finally the retraction of finger or foot from 'painful' electrode is often used.

Trial-and-Error Experiments. Thorndike's cat was put in the problem box in "utter hunger"[5]. Rats must be hungry, thirsty, or under some other "drive" or "tension" to learn a maze, a dis-

[1] Pavlov, I. P., *Conditioned Reflexes* (to be referred to hereafter as *C.R.*). Oxford: Oxford University Press, 1927, 30–31.

[2] Pavlov, *C.R.*, 28–31.

[3] Pavlov, *C.R.*, 30–31.

[4] Jones, M. C., The Elimination of Children's Fears. *J. Exper. Psychol.*, 1924, 7, 382–390, esp. 389.

[5] Thorndike, E. L., *Animal Intelligence*. New York: The Macmillan Company, 1911.

crimination problem, or a problem box, as has been especially shown in California studies of incentives under Tolman's inspiration [6].

Gestalt Experiments. Some lure must be used, such as a banana for Köhler's apes [7]. In Aldrich and Doll's researches, lures for (feebleminded) children had to be carefully adjusted for individual cases: they had to be pointed at by the experimenter; or a banana was substituted for a red ball; or a red ball was more effective than a cookie; or a cookie was used to reënforce a ball [8]. Adams has said that exploratory behavior is to be traced to a "need to get information" [9].

II. A Field or Complication of Motives [10] Exists

C-R Experiments. Pavlov's subjects had to be isolated from distracting stimuli [11], *e.g.*, to avoid external inhibitions. Conditioned and unconditioned stimuli have had to be adjusted for relative strengths, as the fear-stimulus *vs.* the alimentary in Mrs. Jones' research [12], or the pain *vs.* the alimentary in Pavlov's [13].

T-and-E Experiments. Measurements have been made of reward *vs.* punishment by Warden and Aylesworth, Valentine, and others [14]; and measurements and comparisons of different incentives

[6] Tolman, E. C., *Purposive Behavior in Animals and Men.* New York: Century, 1932, Ch. III.

[7] Köhler, W., *Mentality of Apes.* New York: Harcourt, Brace, 1925.

[8] Aldrich, C. G., and Doll, E. A., Problem-Solving Among Idiots: The Use of Implements. *J. Soc. Psychol.*, 1931, **2**, 306–336, esp. 330 ff.; Problem-Solving Among Idiots. *J. Comp. Psychol.*, 1931, **12**, 137–169, esp. 161 ff.

[9] Adams, D. K., A Restatement of the Problem of Learning. *Brit. J. Psychol.*, 1931, **22**, 150–178, esp. 156.

[10] In the case of the word "motive", as in those of other words to be used in headings to follow, the writer has no thought of insisting upon his word-choice as the only acceptable one. Alternative words may be substituted in several cases; thus for "motive" substitute "desire", "need", "tension", or "valence".

[11] Pavlov, *C.R.*, 20–21, 44, 115; *Lectures on Conditioned Reflexes* (to be referred to hereafter as *Lectures*). New York: International Publishers, 1928, 144–146.

[12] Jones, M. C., *op. cit.*

[13] Pavlov, *C.R.*, 30–31.

[14] Warden, C. J., and Aylesworth, M., The Relative Value of Reward and Punishment in the Formation of a Visual Discrimination Habit in the White Rat. *J. Comp. Psychol.*, 1927, **7**, 117–127; Valentine, R., The Effects of Punishment for Errors on the Maze Learning of Rats. *J. Comp. Psychol.*, 1930, **10**, 35–53.

in rat maze learning by Simmons, Ligon, Tolman, *et al.*[15] Isolation of the experiment in the laboratory from the experimenter and other extraneous stimuli is usually resorted to.

Gestalt Experiments. When an animal is learning to take a more direct course from entrance to food exit, as in Gengerelli's studies, Adams holds that the learning is a function of three different needs[16]. Lewin's analyses of a child's adjustment under conditions of reward and punishment and other positive and negative "valences", describe his reaction as occurring in a "dynamic field"[17]. In the Aldrich and Doll study, already mentioned, on problem-solving by children, combinations and substitutions of lures were resorted to.

III. Obstruction Is Offered to the Principal Motive

C-R Experiments. The animal is always restrained in a holder; and the human hand is similarly restrained from escaping, as in the shocking experiment. Tension may become so high that, with excessively fine differentiation being sought, a dog may become neurotic[18]. In the salivary C-R, especially the delay and trace varieties, food is not actually given until time for the unconditioned stimulus, and then but little.

T-and-E Experiments. Walls of problem box, maze, etc., block attainment of the food or other object.

Gestalt Experiments. Bars of enclosure, height of lure, etc., have a similar function.

IV. Hyperactivity (or Hypertonicity) Is Aroused

C-R Experiments. For successful conditioning, the animal must be alert, not drowsy, as stated by Pavlov and emphasized by Liddell[19]. It may be a relevant observation by Pavlov that a dog,

[15] Simmons, R., The Relative Effectiveness of Certain Incentives in Animal Learning. *Comp. Psychol. Monog.*, 1924, **2**, No. 7; Ligon, E. M., A Comparative Study of Certain Incentives in the Learning of the White Rat, *ibid.*, 1929, **6**, No. 28; also see Note 6.

[16] Adams, *op. cit.*, 156, discussing Gengerelli, J. A., The Principle of Maxima and Minima in Animal Learning. *J. Comp. Psychol.*, 1930, **11**, 193–236.

[17] Lewin, K., *A Dynamic Theory of Personality: Selected Papers.* New York: McGraw-Hill Book Company, 1935, Ch. IV.

[18] Pavlov, *C.R.*, 290 ff.; *Lectures*, 341 ff.

[19] Pavlov, *C.R.*, 28; Liddell, H. S., *Comparative Psychology.* (Moss, ed.) New York: Prentice-Hall, 1934, Ch. IX, esp. 272–273.

indifferent to strangers as long as he is on the floor, becomes aggressive toward them when placed on his stand and harnessed [20].

T-and-E Experiments. In Small's early work, his rats made "persevering effort", climbed all over the cage, up the maze walls, etc.[21] Thorndike's cat was very restless and showed a wide range of activity [22]. Hamilton, and recently Patrick, have analyzed the perseverance reactions of humans and many species of animals in the quadruple-choice situation into different types [23].

Gestalt Experiments. One quotation from Köhler is applicable to all his apes: "Sultan . . . makes ready to jump, but does not jump; gets down, seizes the box, and, pulling it behind him, gallops about the room, making his usual noise, kicking against the walls and showing his uneasiness in every other possible way" [24]. This principle applies also to that behavior of the animal when he suddenly pauses and notices a new relationship among his objects.

V. The Response Is Multiple and Varied

C-R Experiments. A conditioned response is at first diffuse; *e.g.*, the human finger retraction to a stimulus that is substituted for a shock is only a part of a total response, for the latter includes respiratory change, galvanic skin reflex, etc., as shown in one of Liddell's records [25]. There is Wever's well known finding that the cat's response to a stimulus substituted for a shock includes respiratory and vocal elements (an emotional 'flutter') [26]; and Winsor has found that the salivary C-R of the parotid gland involves also other salivary and even gastric glands [27].

[20] Pavlov, *Lectures*, 256.

[21] Small, W. S., An Experimental Study of the Mental Processes of the Rat. *Amer. J. Psychol.*, 1900, **11**, 133–165, esp. 135.

[22] Thorndike, *op. cit.*

[23] Hamilton, G. V., A Study of Trial and Error Reactions in Mammals. *J. Anim. Behav.*, 1911, **1**, 33–66; A Study of Perseverance Reactions in Primates and Rodents. *Behav. Monog.*, 1916, **3**, No. 13; Patrick, J. R., Studies in Rational Behavior and Emotional Excitement. *J. Comp. Psychol.*, 1934, **18**, 1–22, 153–195.

[24] Köhler, *op. cit.*, 140–141.

[25] Liddell, *op. cit.*, figure on p. 265; Watson, J. B., The Place of the Conditioned-Reflex in Psychology. *Psychol. Rev.*, 1916, **23**, 89–116, esp. the plates; Garvey, C. R., A Study of Conditioned Respiratory Changes. *J. Exper. Psychol.*, 1933, **16**, 471–503, esp. 474–475.

[26] Wever, E. G., The Upper Limit of Hearing in the Cat. *J. Comp. Psychol.*, 1930, **10**, 221–233, esp. 226 ff.

[27] Winsor, A. L., Observations on the Nature and Mechanism of Secretory Inhibition. *Psychol. Rev.*, 1930, **37**, 399–411, esp. 399–402.

T-and-E Experiments. A rat in the maze sniffs at floor and corners, tries to climb partitions, defecates and urinates, enters most of the alleys, etc., etc. An infant at first makes movements of fingers, toes, trunk, face, etc., at sight and sound of a rattle box.

Gestalt Experiments. Here again we might have used Köhler's description of the preliminary behavior of the ape Sultan, as given in the preceding section. Children, normal and feebleminded, show a similar variety of reactions in problem situations calling for insight of the tool-using or box-stacking types; as appears in the researches of Alpert, of Brainard, and of Aldrich and Doll [28].

VI. The Response Is to Relations of Stimuli

C-R Experiments. Eurman, Ivanoff-Smolensky, and other Russians have trained dogs to salivate at tones of four different pitches if heard in the order 1, 2, 3, 4, only; or at hiss, high tone, low tone, and buzzer, in that order only; or at three sounds in one rhythm only [29]. Triangles and other geometrical relations of visual stimulus patterns have been made conditioned stimuli by many workers, especially with monkeys.

T-and-E Experiments. Gengerelli trained rats in a maze to turn right at a T-choice point regardless of the absolute direction and of the distance and of turns previously traversed [30]. Rats, apes, and children that have been trained to discriminate a given figure, as a triangle, from other figures, can then respond to this figure successfully through many variations in its size, rotation, background, negative stimulus, etc. This has been well shown by Fields and by Gellermann [31].

Gestalt Experiments. The darker of two grays can be selected by a chick, an ape, or a child, regardless of the absolute brightness values of the grays, as pointed out by Köhler and confirmed by others [32]. Apes can learn to choose from among different strings

[28] Alpert, A., The Solving of Problem-Situations by Preschool Children. *T. C. Contr. to Educ.*, 1928, No. 323; Brainard, P. P., The Mentality of a Child Compared with That of Apes. *J. Genet. Psychol.*, 1930, **37**, 268–293; Aldrich, C. G., and Doll, E. A., *op. cit.*, *J. Soc. Psychol.*, and *J. Comp. Psychol.*

[29] Pavlov, *C.R.*, 145–147.

[30] Gengerelli, J. A., Preliminary Experiments on the Causal Factors in Animal Learning, II. *J. Comp. Psychol.*, 1929, **9**, 245–274.

[31] Fields, P. E., Studies in Concept Formation. *Comp. Psychol. Monog.*, 1932, **9**, No. 42; Gellermann, L. W., Form Discrimination in Chimpanzees and Two-Year-Old Children. *J. Genet. Psychol.*, 1933, **42**, 3–27, 28–50.

[32] Köhler, W., *Gestalt Psychology.* New York: Liveright, 1929, 216–217.

lying between themselves and the lure in order to pull in the latter, as shown by Yerkes and Köhler [33]; and further elaboration of this pulling-in technique to test "equivalence of stimuli" has recently appeared at the hands of Klüver [34].

VII. The Most Important Relation Is Between Means and Objective

C-R Experiments. In Wever's study on the cat as aforementioned, during the interval of delay between the conditioned and the unconditioned stimulus, a change of breathing follows immediately upon the conditioned stimulus that is of a "flutter" type, and differs definitely from the breathing change finally elicited by the conditioned stimulus [35]. As shown by Anrep and by several in Hull's laboratory, conditioned salivary, winking, respiratory, and galvanic responses come to appear at moments in advance of the unconditioned responses: they are thus anticipatory responses to warnings [36].

T-and-E Experiments. Discrimination habits are really signal habits; and in their formation the closeness of relation between the true signal and the tension-releasing situation, such as food, is important, as shown by Lashley and by Munn [37]. Important also are the delays of feeding in maze and problem box investigated by Hamilton, by Roberts, and others [38].

[33] Köhler, *op. cit., Mentality of Apes,* 28 ff.; Yerkes, R. M., The Mind of a Gorilla. *Genet. Psychol. Monog.,* 1927, **2**, Nos. 1 and 2, esp. Ch. V.

[34] Klüver, H., *Behavior Mechanisms in Monkeys.* Chicago: Univ. of Chicago Press, 1933. *Cf.* also Richardson, Helen M., The Adaptive Behavior of Infants in the Utilization of the Lever as a Tool. *J. Genet. Psychol.,* 1934, **44**, 352–377.

[35] Wever, *op. cit.;* emphasis upon the anticipatory character of the conditioned response, also in Hull, C. L., A Functional Interpretation of the Conditioned Reflex. *Psychol. Rev.,* 1929, **36**, 498–511, esp. 507 ff.; Garvey, *op. cit.,* and Switzer, St. C. A., Anticipatory and Inhibitory Characteristics of Delayed Conditioned Reactions. *J. Exper. Psychol.,* 1934, **17**, 603–620.

[36] Hull, C. L., Learning: II. The Factor of the Conditioned Reflex, Ch. 9 in *Handbook of General Experimental Psychology.* (Murchison, ed.) Worcester: Clark Univ. Press, 1934, 382–455, esp. 388, 392, 433–434; Switzer, *op. cit.*

[37] Lashley, K. S., The Mechanism of Vision: I. A Method for Rapid Analysis of Pattern-Vision in the Rat. *J. Genet. Psychol.,* 1930, **37**, 453–460; Munn, N. L., An Apparatus for Testing Visual Discrimination in Animals. *J. Genet. Psychol.,* 1931, **39**, 342–358.

[38] Hamilton, E. L., The Effect of Delayed Incentive on the Hunger Drive in the White Rat. *Genet. Psychol. Monog.,* 1929, **5**, 131–207; Roberts, W. H.,

Gestalt Experiments. Tolman, in his reinterpretation of maze learning, calls the alleys, turns, etc., "means-objects" and parts of a "sign-gestalt" [39]. Tool-using and box-stacking are quite obviously means, and are cardinal to Gestalt theory, as is also the child's appealing for help from the social environment in Alpert's and Brainard's reports [40].

VIII. Selection or Least Action Appears

C-R Experiments. After continued elicitation of a particular C-R at one specific place, kind, or degree of stimulus, the response to other environmental elements, as well as to other degrees of the same mode, such as tone-pitches, weakens and disappears, and excitability becomes focussed at the specific point or pitch. This is Pavlov's "law of concentration" [41]. This process is accelerated by the use of other stimuli without reënforcement—the law of "differentiation".

T-and-E Experiments. Entrances into blind alleys of a maze, excess clawings, mewings, etc., in a problem box, wrong choices in a discrimination apparatus, all tend to be eliminated in the course of learning, leaving only the correct movements. Even Thorndike's cats, if allowed to escape upon licking or scratching themselves, gradually reduced this act to vestigial proportions [42]. Then there is the well known finding of DeCamp, verified by Kuo and many others, that the shorter of two alternative maze paths is eventually chosen by rats [43].

Gestalt Experiments. Helson's rats in a discrimination box were said to demonstrate insight when, after entering the wrong compartment, they climbed over the partition to the food, instead of crossing the grid [44]. Maier's rats at large in a room showed "reasoning" (his term) by combining some earlier experiences to find the shortest

The Effect of Delayed Feeding on White Rats in a Problem Cage. *J. Genet. Psychol.*, 1930, **37**, 35–58.

[39] Tolman, *op. cit.*, Chs. IV, VI, VII, IX, XII.

[40] Alpert, *op. cit;* Brainard, *op. cit.*

[41] Pavlov, *Lectures*, 157–158, 188, 209; *C.R.*, 115, 157, 167.

[42] Thorndike, *op. cit.*, 48.

[43] DeCamp, J. E., Relative Distance as a Factor in the White Rat's Selection of a Path. *Psychobiol.*, 1920, **2**, 245–253; Kuo, Z. Y., The Nature of Unsuccessful Acts and Their Order of Elimination in Animal Learning. *J. Comp. Psychol.*, 1922, **2**, 1–27.

[44] Helson, H., Insight in the White Rat. *J. Exper. Psychol.*, 1927, **10**, 378–396, esp. 392–394.

elevated pathway to the food [45]. Gengerelli's monkeys, having to press down in any order four levers widely spaced from each other, developed a tendency to depress the levers in such an order as to involve fewer and fewer movements [46]. Once insight was gained, Köhler's apes and Alpert's children proceeded to stack boxes or use sticks with a minimum of waste effort [47].

IX. The Selected Responses Originally Occur Fortuitously

C-R Experiments. Almost any response can become conditioned to almost any stimulus if only the latter chance to be present along with the unconditioned stimulus with sufficient frequency and relative intensity.

T-and-E Experiments. The successful response occurs in the course of the restless and so-called random behavior.

Gestalt Experiments. The successful response (*i.e.*, the insight) occurs typically only after an amount of random behavior, though upon once occurring it may not need repetition for "stamping in". For example, in Ruger's puzzle solving, insight emerged often by degrees and in consequence of semi-fortuitous movements (to use his own phrase) [48].

X. The Effects of Responses Are Crucial

C-R Experiments. Reënforced responses become stronger; unreënforced become weaker and eventually inhibitory. Liddell makes the significant observation that a sheep that has been conditioned to flex the foreleg at a given stimulus will, if it be placed on its back, now display a series of righting reactions to that stimulus; also that when the sheep is standing with its head turned, its only response to the stimulus mentioned is to correct the position of the head [49].

T-and-E Experiments. Various rewards and punishments in maze learning have been graded on the basis of their effects, in experimental studies by Tolman, Warden, Simmons and others [50].

Gestalt Experiments. Alpert found with her child subjects that a good insight, in fact the solution itself, was quickly abandoned if

[45] Maier, N. R. F., Reasoning in White Rats. *Comp. Psychol. Monog.*, 1929, 6, No. 29.

[46] Gengerelli, J. A., The Principle of Minimum Path in the Ringtail Monkey. *Publ. of Univ. of Calif. at Los Angeles*, 1933, 1, No. 13.

[47] Köhler, *op. cit.*; Alpert, *op. cit.*

[48] Ruger, H. A., The Psychology of Efficiency. *Arch. Psychol.*, 1910, No. 15.

[49] Liddell, *op. cit.*, 273.

[50] See Notes 6, 14, and 15.

not followed by attainment of the goal [51]. The sudden drops in the learning curve that are taken as evidence of insight by Koffka [52] follow usually upon successes.

XI. The Rate of Learning Varies in Degrees from Gradual to Abrupt

C-R Experiments. Hilgard and Garvey have demonstrated that the eyelid and the respiratory C-R's, respectively, in the process of their becoming established, gradually increase in intensity and in frequency of elicitation, and the rates of increase can be plotted as learning curves [53].

T-and-E Experiments. The most common method of representing learning of this class in practically all researches is with learning curves showing progressive changes in errors, time, distance, etc.

Gestalt Experiments. In Aldrich and Doll's studies, the improvement by feebleminded children in successive solutions of tool-using and of box-stacking problems is greatest between the 1st and 2nd trials, but also is evident between the 2nd and 3rd; and learning curves of sharp negative acceleration are derived [54]. Further, the abruptness-gradualness of acquisition varies in many degrees with different subjects on the same problem [55].

III

The question naturally arising now is: how has there come about such a distinction of theories, such an array of conflicting polemic camps?

One answer is to the effect that in the comparative survey of learning in different animal forms and phyla there has often been a tendency to take as peculiar to some particular animal-level a sort of learning that happens to be more noticeably characteristic in its case—as if it were its sole characteristic and its exclusive characteristic. For example, it may seem that the trial-and-error sort of

[51] Alpert, *op. cit.*, 55.

[52] Koffka, K., *Growth of the Mind.* New York: Harcourt, Brace, 1928, 164 ff.

[53] Hilgard, E. R., Conditioned Eyelid Reactions to a Light Stimulus Based on the Reflex Wink to Sound. *Psychol. Monog.*, 1931, No. 184, esp. 11–17; Garvey, *op. cit.*, 486–488. *Cf.* also Hull, *op. cit.*, Learning, etc., 425.

[54] Aldrich, C. G., and Doll, E. A., *op. cit.*, *J. Comp. Psychol.*, 157 ff.; *J. Soc. Psychol.*, esp. 327 ff.

[55] See, also, references in Note 28.

learning is the prototype; for is it not recognizable in the metazoa and the protozoa, and is it not the more characteristic of the adjustments of subhuman forms than of rational human beings? The conditioned-response type is likely to be thought of then as appearing only later, after the differentiation of reflex movements out of more tropic organismic behavior, and hence best observable in vertebrates and especially in mammals. And, finally, insightful adjustments are likely to be conceived as late products of mental evolution, when in anthropoids and especially in man the appreciation and elaboration of the relationships of environmental stimuli are made possible. Trial-and-error, then, is the prototype; conditioned response, the product of evolved individuation; insight, the expression of further-evolved organization.

(1) Concrete examples, however, show us the hastiness and superficiality of this phylogenetic view. Consider an experiment upon the lowliest of all animals, that by Mast and Pusch on the amoeba [56]. Their description of how this animal eventually learns to send out its pseudopods not into a lighted area but in the other direction reads, at first, like a description of trial-and-error. But the similarity between retraction of pseudopod from light and the retraction of a human finger from an electrified grid raises a strong suspicion that amoeba's negative response may be subsumed under the head of conditioning. And, on the other hand, the similarity between the amoeba's response to the lighter-of-two-areas and the chick's or the ape's response to the darker-of-two-grays in Köhler's studies, suggests that we may have in primordial form just another case of relational or configural learning.

(2) At the opposite pole of subhuman behavior we have the studies on monkeys and apes by Yerkes, Bingham [57], Köhler, Klüver, and others, in which detour, string-pulling, stick-using, stick-making, box-stacking, etc., are employed. In such accounts the try-try-again feature is outstanding, but so also is the fact that these "tries" are responses to this, that and the other configuration or relationship among boxes, doors, and the lure; this is trial-and-error, then, and insight, too. What of conditioning? The behavior is exceedingly complex; and it is a tenable supposition that upon analysis it would break down into conditioned responses. The latter point borrows

[56] Mast, S. O., and Pusch, L. C., Modification of Response in Amoeba. *Biol. Bull.*, 1924, **46**, 55–59.

[57] Bingham, Harold C., Chimpanzee Translocation by Means of Boxes. *Comp. Psychol. Monog.*, 1929, **5**, No. 3.

cogency from Klüver's work on monkeys [58] in which he analyzes at great length by the pulling-in technique that essential of all insight—reaction to simple configurations as ratios; for it is all of a piece with the conditioned-response theory to explain the choice of strings-to-be-pulled on the basis of negative conditioning to the wrong and positive conditioning to the true string.

(3) As with phylum changes in the animal kingdom, so with age changes in the individual; for in the genetic treatment of learning in the human, again the trial-and-error type has appeared as the crudest and the most characteristic of earliest infancy, while conditioning, and much more, insightful response, has been supposed to be better displayed by older children and adults. But compare some typical experiments upon infant learning. In the study by Sherman and Sherman, diffuse defense reactions were observed in the youngest infants; but with increase in age, they became less indefinite and irregular, and a more coördinated response became established [59]. Quite a different study is that made by Jones [60] in which conditioned galvanic skin reflexes were established in 3 infants from 3 to 9 months of age. And still different is another experiment by Jones [61] wherein he found kindergarten children to show consistent tendencies to make relative choices. After being trained to choose one card differing in size, form, brightness or color from another card, they tended to choose that one of any pair that bore the same relative character. From all of which we see that in infancy learning may appear that will fit under any of the three dominant theories.

(4) At the opposite pole of human behavior we have an array of experimental studies of learning on the level of thinking by the adult. That the type of adjustment called thinking exhibits the feature we call trial-and-error is apparent enough. Ruger's early work [62] brought this out. Heidbreder's more recent study, too, is replete with accounts, both subjective and objective, of how her subjects slashed about in their search for solution [63]. But the subject was

[58] See reference in Note 34, *supra*.

[59] Sherman, M., and Sherman, I. C., Sensori-Motor Responses in Infants. *J. Comp. Psychol.*, 1925, **5**, 53–68.

[60] Jones, H. E., Retention of Conditioned Emotional Reactions in Infancy. *J. Genet. Psychol.*, 1930, **37**, 485–498.

[61] Jones, H. E., and Dunn, D., The Configural Factor in Children's Learning. *J. Genet. Psychol.*, 1932, **41**, 3–15.

[62] Ruger, *op. cit.*

[63] Heidbreder, Edna, An Experimental Study of Thinking. *Arch. Psychol.*, 1924, No. 73.

hardly just "slashing about"! Rather was he veering and tacking carefully between one and another manner of "noticing" and "thinking about" this and that, *i.e.*, between modes of perceiving, conceiving, imagining, inferring, etc., or, in the language of the Gestalt school, of *structuring* the situation.

So much for trial-and-error and for insight: what of the conditioned-response view of thinking? We must admit this to be a large order. A suggestive beginning has, however, been made in Lepley's experimental demonstration that some phenomena of memorization are identical with or, at least, similar to some phenomena in conditioning [64]. A mere beginning, to be sure, and one still far removed from the complexities of original and creative thought; but some *theoretical* envisagements of intellectual processes in terms of conditioning have been offered by others; and time awaits their experimental verification. Meanwhile, the very sound of some of the principles of conditioning have the ring of some of the principles of thought processes—"generalization", "differentiation", "inhibition", "delayed reaction", "positive and negative induction", and the like.

We may conclude, then, that ontogenetically as well as phylogenetically, learning that goes on at any one level of development does not show the *exclusive* appropriateness of any one of our three general learning theories.

IV

Another explanation for the presence of these three major learning theories in the field is to be found in their *experimental* origins. Each is the rationalization and interpretation of a *technique*.

(1) The trial-and-error doctrine grew out of observations and experiments on the behavior of dogs and cats, partly as a critique from the genetic point of view, of the popular anthropomorphizing tendency in the usual anecdotal accounts; and the fruitfulness of the approach has led to an historical procession of white rats through their mazes and problem boxes. Now, for one thing, it is important to note that in all of these experiments the subjects have been *whole* animals, *whole* organisms. For another thing, it is to be noted that, for one reason or another, the situation which each one was called upon to solve was one that *did not provide* or include a *stimulus* pattern that would call out some *response that was already a part of*

[64] Lepley, William M., Serial Reactions Considered as Conditioned Reactions. *Psychol. Monog.*, 1934, No. 205.

the animal's repertoire and adequate to the situation; no meat powder to elicit the all-important salivary reflex, no stick with which simply to reach out for the all-important banana.

(2) The conditioned-response doctrine arose out of experimentations in a physiological laboratory, themselves growing out of an interest in gastric and salivary secretions. The dog studied now was not the *whole* dog, at least not intentionally, for experimental *isolation* of the *particular gland* or the *particular motor unit* was attempted, and at the same time a similar *isolation of stimulus* from the remainder of the environment, to the extent of providing sound-proof, light-proof, vibration-proof rooms.

(3) The insight doctrine of learning grew out of observations primarily upon higher animals, which were left more at liberty to adopt whatever responses they would. The *whole* animal was studied again; for it, however, the solution of the problem was not indefinitely delayed by the necessity of developing a new sensori-motor coördination, but was rendered possible just as soon as the animal would *notice* some critical thing about it all, *some significant relationship*. In conventional psychological language, the problem was not so much a *motor* one as a *perceptual* one.

Thus, our three main learning theories have sprung from quite distinct origins in experimental research. Human enthusiasms, propaganda, and polemics have emphasized the distinctness of these origins and exaggerated the contrasts between the derived theories. It should be evident enough, however, from many of the references in the preceding pages that after all, the differences of the theories are founded on matters merely of more and less.

For one thing, it is a matter of *how far you want to go in your experimental analysis* of learning. If you want to get down to the simplest possible segments of learning behavior, you can find reflexes substituted for other reflexes. It is like a physiological analysis of particular component body processes. The immensely important question remains, however, whether you can reconstitute and characterize the whole merely out of knowledge of the component parts.

For another thing, it is a question of *how far you want to test for capacity to respond to relationships*. If you want to explore the higher reaches of such capacities you find yourself working with intellectual processes of abstraction, conceptualization, inference, and inspiration. It is the danger of careless and gratuitous theorizing here, however, that must be guarded against.

V

A final word of warning against certain thoughtless and exaggerated descriptions! First, there is no such thing as an *isolated* conditioned response. Surely enough has been presented under Principles II, IV, and V to establish this. Secondly, there is no such thing as *pure* trial-and-error. The trials made by the same animal or person in very different situations will differ vastly in character, as when drowning, when hungry, when suffering toothache, when in helpless rage. Thirdly, there is no such thing as *wholly spontaneous* insight in learning. However sudden its appearance may be, the new way of looking at the situation is a function of the past experience of the animal or person and of that particular animal or person. As Bingham's chimpanzees would stack several boxes to reach a very high lure only after they had earlier learned to place one box to reach a low lure, so a mechanic, a physician, and a lawyer would be quite unable to help each other with penetrating insights into each other's problems.

All such extreme characterizations, then, are caricatures; and as these supposedly differentiating traits lose their sharpness of focus, the three kinds of learning lose some of their disparateness and contradiction, and a description and interpretation of all learning phenomena in general seems a sensible possibility. In organizing such a description, the principles I have suggested in the first part of this paper would seem to be useful.

EXPERIMENTAL STUDIES OF LEARNING IN INFANTS AND PRESCHOOL CHILDREN

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An extensive bibliography on the general field of learning has recently been published by McGeoch (**63**). This has been followed by a critical review of adult learning as compared with child learning by Ruch (**87**). Razran (**78**) has contributed a detailed summary of experimental work with children under the concept of the "conditioned response". Peterson (**75**) has also written a survey of experiments on learning in children from the genetic point of view.* Jersild (**41**) has reviewed the problem of training and growth in children. These treatments, however, have not covered in any comprehensive fashion the experimental work in learning now available in the rapidly expanding literature on the infant and preschool child. It is the purpose of this review to furnish such a survey.

The significance of the study of learning at these early ages has been effectively stated by Peterson (**75**, p. 316): "Learning in infants and young children differs sufficiently from learning in adults to make special investigation of the former desirable, not only from the point of view of the child and its proper education, but also from that of a better understanding of adult learning."

For the purpose of this review an investigation is classified as a study of learning if it has sought to describe change in behavior subsequent to a known amount of contact with a known and relatively constant physical situation. Incidental observation and habit and achievement inventories at any age level are excluded. Studies of immediate memory (delayed reaction) are omitted since they are conceived as being quantitatively, if not qualitatively, different from learning as generally conceived. The studies are roughly classified for convenience according to the major emphasis of each.

* Since the preparation of this review Peterson has revised and somewhat amplified his survey. (*Handbook of Child Psychology*, Second Rev. Ed. Worcester, Mass.: Clark Univ. Press, 1933.)

Studies on Conditioning

The following studies on conditioning, published in Russian, have been reviewed in some detail by Razran (**78**): Denisova and Figurin on conditioning, differentiation, and experimental extinction of food seeking responses in 11 infants 10 to 54 days of age; Levikova and Nevymakova on conditioning of food seeking responses in 5 infants, ages 14 to 86 days; Slutskaya on conditioning avoiding responses in 5 children aged 11 to 21 months; and Ivanov-Smolensky on conditioning grasping in children 4 to 6 years of age.

The Russian publications of Krasnogorski as well as his publications in other languages are also reviewed by Razran. Krasnogorski has established a laboratory for the investigation of conditioned reflexes in children in which he and his students have already repeated many of Pavlov's earlier experiments. Little of the work, however, has been completely reported. An early article (**55**) describes conditioned salivation in 1 three-year-old and 2 six-year-old children. Conditioning to a bell or a tuning pipe was measured by an increase in number of swallowing and mouth opening reactions which were kymographically recorded. Conditioning was also effected to the tactual stimulus of a scratch on the arm. In the 2 older children this stimulus was differentiated from a scratch on the foot. However, in the younger subject the stimulus was originally specific. Trace conditioned reflexes over an interval of 10 seconds were also demonstrated.

Elsewhere Krasnogorski (**56, 57**) stated that infants 5 to 6 months of age could differentiate between white and red lights and infants 7 to 8 months of age could differentiate odors. He also described a rather unusual form of differential inhibition in a child of 5 years who was trained to respond only to a former conditioned stimulus (a bell) when it was followed after a three-minute interval by tactual stimulation. A more recent article (**58**) summarizes some of the work begun in 1907 and describes the refinements in technique which are being employed, especially in regard to the actual collection of saliva by means of small saliometers. Both natural and conditioned salivation are reported in a nine-month-old infant as recorded by the early "swallowing" technique.

Ray (**77**) has reported a technique for use in studies of fetal conditioning. The essential apparatus consisted of 3 tambours fastened to the mother's abdomen with tape. Accessory records included a pneumograph and a sphygmomanometer for recording the mother's

breathing and pulse rate. A further check was obtained by having the mother press a key when she felt the fetal kick.

Marquis (65) conditioned sucking responses, decreased activity, and decreased crying to a buzzer in 7 of 8 infants during the first 10 days of life. The infants were bottle fed 6 times per day in a Pratt experimental cabinet. A stabilimeter recorded activity; pneumograph records supplemented observations of sucking. A control group receiving the same sequence of stimuli except feeding in the cabinet showed no signs of conditioning. The conditioned responses in the experimental infants were not elicited by other stimuli.

An experiment for the purpose of discovering whether or not a three-month-old infant was deaf was conducted by Aldrich (1). The ringing of a small dinner bell accompanied pin-scratching on the foot. After 15 to 20 applications, the infant cried and drew up the leg when the bell was rung.

Ripin (84) recorded 461 observations of the feeding reactions of infants during the first 6 months of life. The observations were made on 272 subjects. Specific feeding reactions were observed in both bottle and breast fed infants by the end of the first month. The placing of the bib acted as the cue in the former case and in the latter a combination of nursing posture, the movement which initiated it, and physical contact with the mother.

Leonow (61) established trace conditioned reflexes in 1 five-month-old infant and 3 children 4½ to 6 years of age. A metronome, tactile stimulation, a lamp, and an electric bell were the conditioned stimuli; chocolate for the older subjects and nursing for the infant were the unconditioned stimuli. The interval between stimuli varied from 5 to 60 seconds.

Gastric secretion in a nine-month-old infant at the sight or smell of milk was noted by Nothmann (74). Secretion after sucking an empty bottle was also found in 2 newborn infants before actual feeding had taken place.

Bogen (7) reported conditioned gastric secretion at the sound of a trumpet in a child 3½ years of age which had to be fed through a gastric fistula. The conditioned stimulus alone effected the secretion, or served to increase the amount normally brought about by the sight of meat or sham feeding.

With 1 four-year-old child Juschtschenko (49) found that, as in older subjects, the conditioned salivary reflex was affected more by a distracting noise than was a conditioned motor reflex. Resek (79) reported a conditioned Babinski reflex in a five-year-old child who

suffered from infantile paralysis and had heightened patellar and Babinski reflexes.

Bayne, Winsor, and Winters (5) kymographically recorded conditioned grasping responses to sound and light in 3 children, 2 six-year-olds and 1 four-year-old child. The latter required 200 to 300 trials to set up the reactions, whereas only 8 to 10 trials were needed by the six-year-old children.

An extensive research was conducted by Mateer (66), using 67 children from 1 to 8 years of age, 7 of them being mentally defective. Conditioning, extinction, retention, and reconditioning were studied. The adequate stimulus was chocolate; the inadequate stimulus, modified from Krasnogorski, was the placing of a bandage over the eyes of the subject. She found that conditioning in normal children for the age range studied required 3 to 9 trials; that after 24 hours the learned response functioned without further conditioning in over 70 per cent of the normal children; and that extinction in 41 of the subjects required 3 to 12 trials, whereas relearning required 2 to 7 trials. The number of trials for conditioning as well as for extinction was negatively correlated with age up to 5 years, after which age seemed to make little difference. With chronological age held constant, those who learned more rapidly had a higher mental age.

The conditioning of electrical skin phenomena in 3 infants, 3 to 9 months of age, and 5 nursery school children was studied by Jones (44, 45). The galvanometer electrodes were fastened to the feet. The adequate stimulus was an electric shock from an inductorium. In the first series of experiments the inadequate stimuli also gave deflections, but in the second series 2 stimuli, a light, and the click of a small electric armature giving neutral responses, were used. Intensive work was done on 1 child covering a period from the seventh to the ninth month. Conditioning was established usually in from 6 to 14 stimulations. Extinction occurred after 4 or 5 unreinforced stimulations, with spontaneous recovery after 24 hours. Repetition of the unreinforced inadequate stimulus often induced sleep. The response survived in one case for 7 weeks without reinforcement.

Conditioning of Emotional and Affective Responses

Since Watson and Morgan's (95) announcement of the theory of conditioning in relation to emotional behavior, a number of studies have been concerned with the modification of emotional and affective responses to stimuli.

Watson and Rayner (96) reported a study of conditioning a

reaction of "fear" to furry objects in 1 infant. On the first presentation (at 9 months) of these objects no fear was indicated. The striking of a steel bar immediately behind the child's head built up, however, a "fear" pattern of behavior after 3 stimulations. When the infant was 11 months of age, a white rat was presented twice with the striking of the bar. After 5 more simultaneous presentations 1 week later, a test with the rat alone evoked the "fear" pattern. Transfer effects were found to other furry objects. Tests at later periods showed evidences of retention. Thumb sucking was interpreted as a compensatory device.

Unconditioning was not attempted with the child studied by Watson and Rayner (96). A few years later, however, a child 2 yrs.–10 mos. of age already having fear responses to furry objects was used in an experiment by Jones (48). As a means of unconditioning he was placed in a room each day with 3 other children who did not fear a rabbit. A progressive elimination of his fear resulted. After a two-months absence due to sickness, the fear had reappeared as the result of an accidental reconditioning. At this time "direct conditioning" (presenting the rabbit while the child was eating) was employed. An additional factor was the occasional admission of other individuals who showed no fear of the rabbit. The fear of the rabbit and other furry objects was found to be reduced. In a second paper by Jones (47), reporting cases ranging from 21 months to 3 years, the conclusion was drawn that the "direct conditioning" and "social imitation" methods furnish the best procedures in attempting to eliminate fears.

Using one fifteen-month-old infant as a subject, Jones (46) has reported another study of conditioning emotional responses. The subject was allowed to play on a grilled platform through which mild shocks could be administered. A bell was associated with the electric-tactual stimulations. After 3 simultaneous presentations a startle reaction was effected to the bell alone. A buzzer was also then found to be effective. Experimental extinction was slow, but external inhibition was temporarily noted.

Two other experiments have attempted to test Watson's theory. English (17) presented a wooden duck accompanied by the loud striking of a metal bar to a girl 1 yr.–2 mos. of age seated in her own high chair in the laboratory. The sound of the bar elicited a startle, but no fear. No conditioned change to the duck was noted. Valentine (93) also presented evidence in criticism of Watson. At 12½ months, a child seated on her mother's knee showed only mild

curiosity in response to an opera glass in connection with a loud whistle as an adequate stimulus, yet screams were evoked when the whistle was sounded as the child looked at a caterpillar. Other similar instances were reported.

Two attempts have been made to condition "likes and dislikes" of taste stimuli. In the case of a blindfolded child 2 years of age, Moss (71) followed presentations of sweetened orange juice with vinegar. In later series the vinegar was accompanied by the click of a familiar telegraph snapper. After a few days the total situation of blindfold, snapper, and liquid (sometimes water) evoked the "dislike" reaction, though the click of the snapper alone produced no response. After 12 days of the experiment a shivering reaction was noticed to the click alone when the child was playing. Dislike for oranges was also created by the experiment. In a child 4 years of age, vinegar failed to provoke adequate "dislike" reactions for experimentation. Conditioning was established, however, to the snapper from a mild electric shock. Dislike was created for the clicker but not for oranges.

Gauger (23) has attempted to modify response to taste stimuli in 17 young children ranging in age from 1 yr.–6 mos. to 3 yrs.–4 mos. She presented weak salt solution, vinegar, egg white, and strong salt solution. Each stimulation was followed by a square of chocolate. This procedure was continued for 35 days; the children were retested after 80 days. She concluded that the reactions changed from dislike to indifference and even to liking. The reaction to vinegar continued to move slightly toward the indifference point during a series of presentations alone.

Studies in Skill

Several studies have been concerned with the acquisition of skill, primarily in the motor field. In a study of gain in efficiency in grasping a rattle by an eighteen-week-old infant, Curti (9) used the decrease in superfluous or irrelevant kicking movements as a criterion. One trial per day plus a number of uncontrolled presentations was used. The experiment extended over 14 successive days. The practice resulted in practically complete elimination of kicking movements together with prompt grasping of the rattle.

Ketterlinus (51) used 27 children (2 yrs.–1 mo. to 5 yrs.–4 mos.) in some mirror reversal experiments. Three situations were used which required a modification of eye-hand coördination. She concluded that young children learn more slowly than adults; that learn-

ing proceeds more rapidly and accurately as age increases; and that age differences are closely related to the increasing complication of the coördination involved.

Effects of practice in the development of control of hand and arm movement have been reported by Wellman (97). Interested primarily in the development of motor coördination, she repeated the Stoelting tracing board test (which covered a period of 4 days) on 15 children, and her tracing-path test on 49 children. Of the last group, 10 received the test a third time. Since the time between tests was not kept constant, she compared the scores with age norms. She found that, although the first scores were not higher than the norms, scores on the second test were. Practice effects were not indicated on the third test. She found also a speeding up from direction to direction within a day's test which she attributed to motor habituation. No apparent transfer effects were found in tracing from one direction to another.

Monroe (70) has reported a study of the ability to learn and remember the musical scale and rote songs in 161 children from 2 to "under six" years of age. Percentages able to learn the scale (practice unspecified) were given by sexes for the 4 age groups. Two weeks later ("with three intervening reviews") percentages retaining the ability were given. Similar percentages were given for the songs. The songs seemed to be remembered better than the scales.

In a study of the development of cutaneous localization, Dunford (15) has considered practice effects. The experimenter touched with a wooden stylus a point within a map approximately 2 centimeters square on the back of the subject's left hand. The subject localized the point touched by touching as nearly as he could the same point with a stylus held in his right hand. Closing the eyes and other controls were used. Ten subjects at each of the age levels 3, 5, 7, 9, 11, and 14 years were used. Five trials of 50 localizations each were given on different days. At all ages there was a consistent improvement with practice. Accuracy increased slightly from the third to the seventh year. The group variability increased with age.

Associative Learning

Several studies have investigated the learning process in what may be called association. Baldwin and Stecher (3) reported a study of card sorting. The child was required to put cards into 10 different compartments in a tray according to the sample card which

was already in the compartment. The subjects were 56 children from 2 yrs.–5 mos. to 6 yrs.–2 mos. of age. A certain amount of improvement took place over 20 trials and, in some cases, was thought to be due to positional memory or the association value of names.

Kirkwood (**52**) studied associative learning in 180 children 1½ to 6½ years of age. The learning task was presented in 3 ways: (1) a standard form of correct association of each of 20 pairs of blocks and pictures; (2) a "standard form interchanged" requiring new association of blocks and pictures; and (3) "single series" requiring associations on one or the other half of the complete unit. Twenty trials were given on the complete series. Learning on alternate days was more effective than learning on successive days. Learning the "interchanged" forms after learning them in "standard" form was more rapid than the original learning. Fewer trials were needed for relearning after a year. Correlations of the number of trials for learning with mental age were of the order of .50. Confusions in association seemed to arise between blocks, pictures, and block and picture.

In a multiple-choice situation (finding the box in which a toy was concealed) involving certain confusing elements in the alternate stimuli, Meek (**69**) has studied the acquisition of a reading vocabulary. Six words were to be learned, the conditions of practice being varied. The subjects were 16 four-year-old children, 37 five-year-old children, and 15 six-year-old children. The various age groups were divided according to the varied learning program. The results were scored in terms of time, number of correlations, and mis-recognitions. There was rapid learning in the early periods. Too much concentrated practice seemed to have a negative effect. An analysis of the types of error committed by the children was also made.

Foster (**18**) has studied verbal memory in young children. Thirty-one subjects were used varying in age from 2 yrs.–7 mos. to 4 yrs.–9 mos., and in I.Q. from 95 to 148. Each of 8 simple stories was condensed into 1 paragraph numbering from 388 to 472 words and requiring from 126 to 142 seconds to read. Each story was read on 10 successive days to 1 child at a time; the reader paused at about 40 prearranged places in each repetition, giving the child opportunity to supply the correct word or words. Everything the child said was noted. The total number of correct words supplied by the child in each reading was taken as the basic measure of learning. Foster concluded that the learning curves approximated the linear. Proficiency in this type of test was found to correlate with both chrono-

logical and mental age. Massed repetitions did not prove economical for learning, but alternate presentation of stories made no significant differences. Relearning of old stories was hindered by the introduction of other stories in the interval.

Richardson (**83**) made consecutive examinations of a group of 16 infants from 28 to 52 weeks of age. In a multiple string situation, she found that position habits appeared.

In 1909 Guillet (**30**) studied learning and retention of bird and mammal names in a two-year-old child and compared the scores made by the child with those made by an adult. The child's list was half English, and half French and German. The adult learned the names in Japanese. In learning 50 names the child added 2.33 words per repetition; the adult added 4.35 words. After a six-weeks interval the child retained 33 words, the adult 71. For relearning the adult required one-third as many repetitions as the child.

Discriminative Learning

Several investigators have studied learning dependent upon discrimination between 2 or more stimuli. Koffka (**53**) has reported an experiment performed by Köhler with 1 child in which 2 boxes were placed before it, one with a brighter and the other with a darker cover. After 45 trials covering a two-day training period, the child learned to choose the brighter box, which always contained candy. On the critical tests in which the candy was transferred to a still brighter box, the child invariably chose the new and brighter box.

Jones and Dunn (**43**) have suggested that it is easy to overemphasize the seeming configural character of reactions and have reported a study conducted with 80 children with a mean age of 68.2 months, standard deviation 3.2. Systematic changes in 4 variables, area, form, brightness, and hue, were used. Training was given on the 2 middle of 4 units in each case by the method of rewarding a correct choice. The training period of 6 trials for each series was followed immediately by critical tests. They found that wide individual differences existed among their subjects in the tendency toward relative choice and that the frequency of relative choice was related to the efficiency with which discrimination was established in the training series.

Data concerning the relative efficacy of form and background in the discrimination of visual patterns by a child of 1 yr.–3 mos. have been presented by Munn and Stiening (**72**). They constructed a special discrimination box using ground glass backgrounds on which

figure and ground could be independently varied. Ten trials were given daily with a piece of chocolate as reward. They concluded that the child reacts to the "part" rather than to the "whole" configuration, since the shape of the background was not an effective part of the stimulating conditions.

An investigation of form discrimination has been conducted by Gellerman (**26, 27**) with 2 two-year-old children and 2 chimpanzees. A double discrimination box was used. He concluded that the children learned to react to form *per se,* but that the results were not as conclusive in the case of the chimpanzees. The children definitely used symbolic behavior (gestural and verbal). In further tests all 4 subjects were able to react successfully to the positive stimulus regardless of background, of the particular negative stimulus, or of rotation, although the children were generally superior to the apes. Previous learning was found in some cases to facilitate and in other cases to interfere with learning in new situations.

Another study in form discrimination is that of Skeels (**89**). He made use of 2 formboards, 1 composed of geometrical forms, the other of forms of animate and inanimate objects. Receptacles under each block permitted the giving of a reward. Thirty-three children (age range 23 to 46 months) were practiced on the geometrical formboard; 23 three- and four-year-old children were used in the second series. In the geometrical series all but 1 of the children succeeded on the first positive form. The number succeeding on later positive forms was smaller. The mean number of trials on other positive stimuli decreased until the last, where it increased. Seventy-five per cent of the errors were in selecting the previous positive form. In the object board there was some relation between learning and intelligence. The associations seemed to be based both on the positive plus reward and the negative minus reward bases. It was possible to change radically the apparent form of the positive form without breaking down the associations.

In a unit preliminary to a study of the constancy of visual size in children, Frank (**19**) taught children to choose the larger of 2 otherwise similar boxes. There were 30 children ranging in age from 11 months to 7 years. Chocolate was used as a reward. The number of trials necessary to establish the connection ranged from 1 to 29 for the 14 children for whom scores were given. He noted the suddenness with which the learning curve rose and believed that quickness of learning depended more on interest in the game than on intelligence.

Problem Solving

The point of view of the Gestalt school, and particularly of the researches of Köhler, has stimulated a new approach to the study of learning in young children. Köhler reported (54) 2 instances in which he repeated with young children some of his experiments on apes. A girl of 1 yr.–3 mos. was placed in a blind alley on the other side of which was deposited an attractive object. All essential elements were visible. The child first pushed toward the object, then looked around slowly, laughed suddenly, and trotted around the corner to the objective. In another situation, a boy of 2 yrs.–1 mo. was put into a "railed-off space" which contained a stick. The objective was placed outside. The child soon picked up the stick and pulled the object to him. This subject was also found to take circuitous routes without trouble in the barrier problem.

Some of Köhler's problems have been repeated with children by other investigators. Using 44 children ranging in age from 1 yr.–7 mos. to 4 yrs.–1 mo., Alpert (2) utilized 9 variations of 2 of Köhler's problems—suspending toys instead of food to be reached by a chair, block, or blocks and putting the child inside a play pen containing sticks with which to reach a toy. She concluded that "exploration and elimination" is the type of behavior commonest with children and highest in yielding solutions. Solution with "immediate insight" was the most frequent. The correlation with mental age was low. Transfer and retention seemed to be indices of presence and degree of insight. The arousal of insight was favored more by emotional, temperamental, and mental factors than by mental or chronological age.

Langstaff (60) has made a more definite attempt to compare her experimental results with those of Köhler, 6 of his experimental situations being used with 30 children 2 to 5 years of age. The child was not confined inside a pen. Instead, the pen was placed on a table and was covered on 3 sides by glass, the fourth side being made of bars. Two light hollow metal rods formed the tool. In another situation the objective was suspended and could be reached by piling 2 blocks. Langstaff found low correlations between speed of solution and mental or chronological age. There was, however, some positive relation between age and success. She concluded that the behavior of apes and children is very similar except for language. She noted solutions of 3 types—immediate, gradual, and sudden. She classified responses into the following 4 types: exploration (pertinent or random), con-

templation, abstraction (emotional episode or giving up), and vocalization (irrelevant, relevant, or anticipating solution).

With 28 subjects varying in age from 2 yrs.–0 mos. to 4 yrs.–6 mos., Matheson (67) has also studied this type of problem solving. Five situations were used involving the removal of a ring from a hook to release the suspended objectives; the piling of boxes to reach the objective; pulling the correct one of several strings to obtain the objective placed beyond a railing; pulling the objective in by means of a stick; and securing a long stick by means of a short stick before the objective could be reached. A fairly high relationship between success and chronological and mental age was shown. "Manipulation" and "pointing and reaching" were the most frequent responses, followed by "feelings of incapacity" and "asking the experimenter for help". It was concluded that understanding of the solution may exist in varying degrees.

Kellogg and Kellogg (50) have used modifications of some of Köhler's problems in a comparative study of development in a human infant and an infant chimpanzee. Four of their experiments may be regarded as problem-solving situations. In one, the hand of the subject was placed in a noose from which he had to extricate it; in another, the foot was placed in the noose; a third was a suspended food situation; and the fourth consisted of procuring an object from behind a railing by means of a wooden rake. They stated that the chimpanzee learned more rapidly and remembered longer, although toward the end of the period (when the child was 1 yr.–7 mos. of age) the child had overtaken and slightly surpassed the ape.

Harter (31) has devised 2 new pieces of apparatus, an obstacle peg test and a canal box test, which she used in experiments with children from 2 to 5 years of age and with adults. A third test was a modification of one of Köhler's problems. Fifty-four children were given all 3 tests; 84 received at least 1 test. Forty adults were given the obstacle peg test, 21 the canal box test. A trial lasted 5 minutes. Harter found that her subjects exhibited considerable overt trial and error behavior in arriving at a solution; that the children who succeeded were older chronologically and mentally than those who failed; that children who succeeded on the obstacle peg test made fewer moves than those who failed; and that the performance of adults on the first 2 tests was similar to that of the children who succeeded except for greatly reduced time.

Several studies have considered the child's ability to generalize (verbally or otherwise) in a problem situation. Heidbreder (35)

used 10 children from 2 yrs.–6 mos. to 3 yrs.–6 mos. of age; 10 others from 4 yrs.–0 mos. to 5 yrs.–0 mos.; 10 school children from 6 yrs.–0 mos. to 10 yrs.–0 mos.; and 10 university undergraduates. She presented 3 relatively simple problem situations in which a choice was offered between 2 boxes differing either in cover design or position. The object sought was always in the same box. She concluded that general ability to solve such problems and responsiveness to problems as such increases with age. She noted a gradual emergence of a pattern or mode of procedure and a change from a more subjective to a more objective attitude toward the problem as a whole. Heidbreder (**34**) has also studied and classified the reasons used in solving these problems. She found age differences in the frequency with which reasons were given and in the complexity and quality of the reasons.

Roberts (**85**) has studied problem solving in a three-choice situation in which similarity in color between an airplane and a door was the only systematic principle to be learned. Forty-three preschool children 2 to 5 years of age were used. All children solved the problems, although not all of them discovered the principle. There was some relation between chronological age and performance. Both immediate and deferred solutions were noted.

Roberts (**86**) also sought to study the process by which young children solve an initial situation and apply the solution in a subsequent series of similar situations all of which could be solved according to the same plan. She also wished to study the effect of hints. Her subjects were 21 nursery school children from 3 yrs.–6 mos. to 4 yrs.–6 mos. of age and 19 orphanage children from 4 yrs.–9 mos. to 7 yrs.–10 mos. Three groups of learning situations were devised based upon color, form, and size with the use of a multiple-choice box of 6 double compartments closed by doors. Twelve trials were given per day. If the problem had not been solved at the end of 36 trials, a hint in general terms was given before each further trial. If solution had not been achieved at the end of 42 trials, a hint in specific terms was given. Only 12 subjects solved the problem unaided; 28 required hints. None of the orphanage children needed over 7 hints, although 25 per cent of the nursery school children, who were younger, required more than that number. Mere perception of the similarity between the door and the object was not sufficient to bring about solution. About 50 per cent of the children made immediate application of the solution in subsequent situations.

Révèsz (**80**) has studied "associative inhibition" and the ability

of children and monkeys to discover the system in problem situations. In studying the first problem he presented from 5 to 8 boxes of the same size, form, and color under one of which chocolate was placed. After learning this position, a second position was required to be learned. In a second series choosing a yellow box after learning a red box was required. In the third problem, he required the child to learn that he must choose the box following the correct one in the previous trial. In the first problem the children usually quickly solved the first situation. He found associative inhibition (persistent choice of the first box learned) only in children of 4 years of age and younger. Most children used the topographical cue. Rhesus monkeys had difficulty in solving the first unit (position change), although they, like the youngest children, restricted the zone of choice. The monkeys were able to choose the box marked with a green triangle from among the boxes marked with other figures in different colors but were not consistent when the position was changed. Of 23 children from 3 yrs.–4 mos. to 4 yrs.–11 mos. of age, only 1 failed. The younger children failed on the last problem. Several methods of solution were found among the older children.

Nelson (**73**) has studied learning in children 2 to 6 years of age under conditions where associative learning could be facilitated by the derivation of a rational principle. She employed Haught's (**32**) adaptation of the Peterson rational learning test. Adult performance was found to be similar to that of the children. Number of trials requisite to learning was more closely related to mental than to chronological age.

Hicks and Stewart (**37**) investigated the ability of 40 children from 2 to 5 years of age to learn to select the middle-sized of 3 boxes differing only in size. Six boxes gave the possibility of 4 series of choices. The criterion of learning was 15 perfect trials. If the problem was not learned after 90 trials (6 practice periods), the child was dropped. The child was told before each trial and after failures, "The toy is always under the middle-sized box". Nine of the two-year-old group were the only ones failing to profit by the repeated instructions; 52 per cent of their choices were made on the basis of position. The 31 successful children confused the middle-sized box with the largest box in a series twice as often as with the smallest one in all series. All of these children were able to apply the concept "middle-sized" in the succeeding series.

From a study of a six-year-old child and a three-year-old child, Dallenbach (**10**) found that the six-year-old subject who did not

understand the relationship of opposition "learned it immediately upon gaining insight" into the problem. The three-year-old subject failed to solve this situation by the method of help used.

Kreezer and Dallenbach (59) studied the learning of the same relationship in a more elaborate setting. One hundred children were used, 20 children at each half-year age level from 5 to 7½ years. In a preliminary teaching period, the use of the word "opposite" was taught to the children who did not already know it by the use of words, "good-bad" and "big-little". Ten words were then given and, if the child did not understand, the relations "good-bad" and "big-little" were explained again and the same 10 words were repeated. Fifteen more words were then given. It was concluded that learning the relationship appeared to be "a sudden shift from free chance association to association determined by the relationship of opposition".

The development of a verbal concept of relationship in children from 5 to 7 years of age was studied by Reymert (81). A sequence of tests using hand-motor reproduction of a series of stimuli was employed. The sense fields of the stimuli were varied, but a similar underlying plan of relationship was incorporated in the tests. Reymert concluded that "training with different kinds of sense material, according to a similar underlying plan of relationship, carries with it, bye and bye, the development of abstract helping devices for memorizing" (81, p. 61). Verbal concepts in particular were used as aids, especially in the case of the older children.

Hazlitt (33) has studied children's thinking in situations which required the child to make exceptions and to generalize. Colored and black cards were mixed with black cards of a smaller size. The children were given the instruction to call the larger black cards K, all the others being put in a separate pile. The children were then required to identify the K cards, serially presented. The whole process was then repeated. Children succeeding were asked "how they would tell someone else which were the K's". Children under 5 often could make the exception practically but could not verbalize it. Two stages of verbal formulation were found. In a test of generalizing ability, 4 trays containing 1 object common to all and 1 different were used with the instruction to choose the object common to all. Giving children who failed instruction by naming all of the objects in the tray once did not yield gains.

In an extensive study of the development of visual perception in school children, Line (62) has reported data collected with 1 group

of 25 subjects 3 to 5 years of age. Age showed a correlation of .61 with score in ability to perceive a constant relation in a card sorting test following a demonstration of the principle involved. As a result of some subsidiary experiments which were not reported in detail but in which a training period with 2 shades of gray and a critical test with 1 shade altered was given, Line stated that children 2½ to 3 years of age tended to react more to a specific stimulus than to a pattern as the shades became increasingly disparate in saturation or distant in space, or as the critical test more closely followed the training period.

Another variant of the problem situation has been the maze. Gellerman (**25**) has studied the behavior of 38 children 3 to 13 years of age in a double alternation temporal body maze. In another study (**24**) the behavior of the macaque in the same maze used by the children is reported. With the children, a minimum of verbal instruction was given. After 3 minutes, the instruction to "keep moving" was given if the subject paused. Reward was also necessary in the case of the three- and four-year-old subjects. Verbal reports were also asked for. The children exhibited the same stages of learning as the monkey—a "random" stage, a stage of regular running, and a stage of hesitation prior to certain responses. There was a tendency for the human subjects to formulate the solution verbally. At 5 years of age the children's trials ranged from 8 to 37, whereas the range with monkeys was 72 to 134 trials. The 2 three- and four-year-old children failed after 30 and 42 trials respectively. The number of trials required correlated —.28 with age.

Batalla (**4**) has investigated the behavior of children in a triple-choice maze, previously described by Davis and Batalla (**13**), when the final common path of the 2 short equidistant paths is blocked and only the third and longer path is left open. Children ranging in age from 30 to 143 months were divided into 5 experimental groups. They were given preliminary trials in which it was seen that all subjects became acquainted with all 3 paths in the maze. Critical tests were then given in which the final common path of paths 1 and 2 was blocked in order to discover whether the subject would go directly to 3 after having been frustrated in 1 or 2, or whether he would choose the other short path first, showing lack of "insight" into the situation. Batalla concluded that children tend to react to the pathways as separate units without a grasp of the total pattern, for the majority returned to the locked common door through the second path on the first test run. Older children were not markedly

superior in the percentage of initial positive runs; younger children, both mentally and chronologically, were found to perform in a less "stereotyped" fashion.

In 3 simple body maze designs Wenger (98) has studied the behavior of 39 nursery school children, age range 1 yr.–11 mos. to 4 yrs.–3 mos. and 40 orphanage children, age range 1 yr.–0 mos. to 4 yrs.–9 mos. At first, more than 1 path to the exit was open. Later the path habitually taken was blocked. The majority of the subjects continued entering the path selected on the first maze trial. Retention was demonstrated after a period of 1 week. The variability of a few subjects was attributed to inadequate motivation or to a comprehension of the nature of the multipath situation. When the path taken was blocked, the younger subjects were unable to adjust to the new situation unaided. For those subjects who learned to take a new path, excess distance showed a higher negative correlation with age than did number of trials or errors. Many subjects learned in 1 trial to take the new path.

Factors Affecting Learning

A number of researches have attempted to analyze certain factors affecting learning. In this review these studies have been divided into 2 groups: (1) studies of the relation of general development (maturation) to learning efficiency and (2) analytical studies of factors in learning.

Relation of General Development to Learning. With the purpose of evaluating the relative effects of training and maturation in achievement, Gesell and Thompson (28) studied block manipulation and climbing stairs by the method of "co-twin" control. The initial age was 46 weeks. Twin T first received daily specific practice consisting of twenty-minute periods of training in both achievements for 6 weeks. At the end of this time Twin T was superior to Twin C in climbing. Twin C then received 2 weeks of specific practice in climbing and gave a performance, as measured in terms of time required to climb the stairs, superior to that of either at the end of the first 6 weeks. Gesell and Thompson emphasized the preponderant importance of maturational factors in the determination of infant behavior patterns.

On the same pair of twins studied by Gesell and Thompson (28), Strayer (92) studied by the method of co-twin control the influence of general development on language acquisition. Twin T received 5 weeks of language training. During this period Twin C heard no

spoken word except when her father visited her. Twin C was then given a training period of 4 weeks. At the beginning of training each twin had only 1 word. A record was kept of the number of stimulations and of the number of responses by each child. Twin C began to acquire words earlier in the period and on comparable days of practice had the larger vocabulary. In phonetic accuracy Twin T was slightly superior. The author concluded that training facilitates the prompt acquisition of language habits and that the effectiveness of training is proportional to maturity.

In a study of the rôle of maturation in learning, Hilgard (39) used 2 groups of 10 children each, aged 24 to 36 months. For a period of 12 weeks she gave 1 group practice in cutting paper, buttoning, and climbing. The control group, equated for chronological age, mental age, sex, and initial abilities in the 3 skills, was also tested at the end of the 12 weeks and then given an intensive training period of 4 days. This deferred practice was found to be sufficient to bring the scores of the control group to a level similar to that of the practice group. Not only was the control group able to achieve relatively more rapid gains from training, but considerable improvement in all 3 skills was manifested over the twelve-week period during which there was no specific practice. The curves indicated that there was greater improvement in climbing and buttoning in the latter part of the training period, that the learning of cutting was rather constant, and that the first 7 weeks of training in climbing at this age effected little improvement.

On 200 children from 2 yrs.–0 mos. to 10 yrs.–0 mos. of age Jersild (41) tested pulling strength, strength of grip, hopping, lung capacity, vocal reproduction of pitch, vocal reproduction of interval, and, in the older children, color naming and free association. Several months of practice were given the experimental group (3 periods per week). On all tests the practice group scored higher than the controls. Both groups, however, had gained. Retests after 3 months showed significant differences in strength of grip only. Again both groups had gained.

Jersild and Bienstock (42) studied the influence of training on the singing ability of three-year-old children. The ability of 48 subjects from 2 yrs.–7 mos. to 4 yrs.–0 mos. of age was tested; 18 were given 40 ten-minute training periods distributed over 6 months. They concluded that the child's performance in reproducing pitch and interval can be much improved through training and that the scores of the practiced group were reliably higher in the end.

Hicks (38) studied the problem of acquisition of skill in throwing a ball at a moving target. The equated control group method was used. Sixty children, 30 in each group, distributed over the age range of 3 to 4 years were used. Preliminary and final tests were given. Eight practice periods, 1 per week, of 10 throws each were given the experimental group. Both groups showed gain. The practice group gained a more significant amount (74 chances in 100) over the control group on the specific skill practiced than on other motor tests. There was a negative correlation between initial scores and gains.

The Porteus diamond maze was used by Hicks and Ralph (36) in studying the effects of practice in tracing. Of 24 children from 2 yrs.–0 mos. to 3 yrs.–4 mos. of age, 12 received 20 tracings over 10 weeks with the preferred hand and 4 with the nonpreferred hand. The control group traced twice with each hand at the beginning of the experimental period and twice with the preferred hand at the end. Both groups made a considerable gain, but the practice group did not manifest a significantly greater increase in ability over that of the control group.

Sommer (90) has sought to determine to what extent preschool children with articulatory defects improve through group training as compared with an untrained control group. The subjects were 34 nursery school children ranging in age from 26 to 59 months and 27 kindergarten children from 57 to 67 months of age. The groups were paired on a number of criteria. The children were tested individually by the Blanton-Stinchfield speech articulation test. Two raters were used. Twelve weeks of corrective work, consisting of 15 minutes of group imitation per day, were given the experimental group. The improvement was 57 per cent in the experimental group and 28 per cent in the control group. No age differences were apparent. Individual differences were quite evident.

In a study of the nature of improvement due to practice in a motor function, Gates and Taylor (22) divided 82 children 4 to 6 years of age into carefully equated control and practice groups. Both groups practiced tapping for 18 days; the practice group then continued practice for 76 days, after which both groups again practiced for 17 days. There were rapid initial gains followed by a negative acceleration. At the end of the experiment no significant group differences were found in tapping or in 8 other motor skills.

Gates and Taylor (21) studied the effect of practice on immediate memory for digits in 2 paired groups of 16 children each. All

children were in the five-year age level. The experimental group received practice for 78 days. The result was a great improvement over the behavior of the control group. This difference disappeared, however, after 4½ months without practice in either group. Three and one-half months later, after both groups had been given 22 days of intensive training, the 2 groups remained equal in status.

Davidson (12) has studied the effect of mental age on the acquisition of a reading vocabulary. Children of this mental age do equally well. Thirteen children, all having a mental age of 4 years on the Stanford test, were used. The bright group included 5 children, the average and dull groups 4 children each. Over a 4½ months period, the average and dull children received 80 training periods, the bright 76. Ten-minute individual periods were given daily plus a usual brief daily group game. Special training methods were used. Some of the children learned to read in a manner comparable to that of average first-grade children. Individual differences were very large. Achievement was directly proportional to brightness.

Specific Factors Affecting Learning. The more analytical studies of learning have covered motivation, analysis of the mechanism involved, facilitation over a long period, transfer and interference, the effects of varied guidance, whole *versus* part learning, and the influence of complexity on the form of the learning curve.

Eigler (16) studied the ability to learn to synchronize a finger reaction with a recurring flashlight. The light was flashed for two-thirds of a second at two-second intervals, the problem being to press and release a key during the exposure. Shocks could be administered for anticipations, laggings, or complete asynchronizations. Fifty-three children (age range 1 yr.–8 mos. to 5 yrs.–11 mos.) and a group of 20 adults were used. Eigler found that learning occurred in all groups. In the adults learning was more rapid and continued to a higher level of correct response than in the children. There was also a greater number of synchronous responses at a faster rate. The same comparison held true for the older children over the younger. There were, however, wide individual differences. Shock facilitated learning, except where emotional disturbance was aroused.

In a series of experiments Waring (94) has studied the improvement in test situations involving motor and discriminatory skill when language approval (nonsense word) was given or withheld. The paired group method was used in 1 series with 15 children from 2½ to 5½ years of age (also on a matched group of 10 children). The alternating method was used first with language approval, later with

non-language approval, and *vice versa* on 16 children 3 yrs.–0 mos. to 6 yrs.–0 mos. in age range. Practice was given until improvement was noted, with a practical limit of 10 repeats in the first series. Some 4 days of practice were allowed in the second series. The language approval method resulted in uniformly greater improvement than the non-language approval.

Rice (82) sought to investigate the rôle played by eye and hand in the training of perception. Her subjects were 10 pairs of twins ranging in age from 4 yrs.–6 mos. to 7 yrs.–10 mos. One twin of each of the 10 pairs was trained in eye movements by following a moving knob on a diamond track. The other 10 subjects were trained in hand movements on the same pattern by holding on to the moving knob. Eye movements were photographed; improvement in hand movements was judged. No transfer effects of any kind were found from the imposed practice to eye and hand movements of an unrestrained nature nor from directed activity in the one to random activity in the other. Practice effects in the specific activity undertaken, however, were found.

De Sanctis (14) reported a study of visual apprehension in maze behavior using 9 children from 3 yrs.–0 mos. to 6 yrs.–0 mos. of age; 11 children from 7 yrs.–0 mos. to 12 yrs.–0 mos.; and 12 feeble-minded children from 7 yrs.–0 mos. to 13 yrs.–0 mos. in a De Sanctis pencil maze. He stated that general or visual-kinaesthetic orientation does not occur in preschool children, but does occur in older children. In most cases the younger children solved the maze by "trial and error". The feeble-minded behaved more like the older group.

Burtt (8) conducted an experiment with his son, attempting to discover whether vocal repetition of meaningless material presented at a very early age would facilitate learning at a much later period. When the child was 15 months of age 3 passages in Greek were read to him daily for a period of 3 months. On succeeding three-month periods different passages were used until a total of 21 passages was submitted. The training was terminated when the child was 3 years old. Relearning was undertaken at the age of 8 yrs.–6 mos.; 3 new selections of 3 passages each were also introduced. It was found that new material required an average of 435 repetitions per selection, that material presented in infancy required 317 repetitions, and that selections which were presented later in childhood were learned more rapidly than those presented earlier.

Using multiple-T grooved finger and toe mazes, Wieg (99) studied 4 transfer situations with 44 six-year-old children and 17

adults: (1) transfer to the same pattern and the same side of the body as used in learning, (2) transfer to the opposite pattern and the opposite side of the body, (3) transfer to the same pattern but the opposite side of the body, and (4) transfer to the opposite pattern but the same side of the body. In both age groups accuracy and transfer results for speed were always greater from the less efficient to the more efficient limb. The lowest speed and the greatest accuracy records were obtained when the transfer trial was taken on the opposite pattern and with the opposite side of the body from that used for learning. The highest speed and the poorest accuracy scores were made when the transfer trial was taken on the same pattern and the same side of the body as used in learning. The other 2 situations hold intermediate positions and present practically identical results. Transfer scores were found to improve with age. Adults were found to make more mean initial errors than children with each of the 4 learning members, but they also made higher scores for speed. Goal direction was found to be learned before maze form, and form before maze distance.

The influence of verbalization on learning was studied by Pyles (**76**). Learning scores on 3 multiple-choice problems were compared. The subjects were 80 children from 2 yrs.–0 mos. to 7 yrs.–0 mos. of age. Problems A and B consisted of 5 green papier-mache molds modeled in a variety of "nonsense" three-dimensional shapes. Problem C consisted of 5 celluloid animals. In problem B nonsense names were given to the objects. Each object had a cup-like opening in the bottom where the reward toy was placed. Six groups, matched as to chronological age, mental age, sex, and school, were given the 3 problems in varying order. Pyles found transfer effects between the problems, with improvements in performance on successive problems. With this factor ruled out, a median of 4 trials was found for problem C, 7.5 for B, and 16.5 for A. Ninety-five per cent of the group solved problem C in 25 trials or less, 44 per cent solved problem B, and only 14 per cent solved problem A.

In a study of acquisition and interference in finger-maze learning, McGinnis (**64**) studied the achievement of 28 children at the ages of 3, 4, and 5. Fifty trials on a modification of the Young slot maze were given, with 5 trials a day for 10 practice days. The older children were superior to the younger. The influence of this type of learning on other stylus-maze forms was also studied. Positive transfer was found except for temporary interference, although the mazes were designed to produce a maximum of interference. The

relation to intelligence was low. Culs-de-sac at the beginning and near the end were eliminated first.

Goodenough and Brian (29) studied the effect of instruction and guidance on the acquisition of skill in tossing rope rings at a post. Twenty children 4½ years of age were used. There were 20 throws a day for 50 days. The children were divided into 3 equated groups. Group A was given no instruction but praise and encouragement; group B was given preliminary demonstration and instruction and later critical suggestions; group C was taught a definite procedure in addition to the instructions given group B and also was not allowed to experiment with other methods. All groups gained, group A least, group B slightly more, while group C was considerably the most proficient at the end of the period.

Gates and Taylor (20) studied the relative effectiveness of 2 methods of learning to write letters, *viz.*, the tracing and the copying. Matched groups of kindergarten children were used. The tracing group traced letters 5 minutes a day for 5 days. They were then tested in copying and a second similar training period was given. With another series of letters a copying pretest was followed by 9 days of tracing practice and a retest. The copying group practiced 8 days each on the same 2 series of letters. There were complete records on 21 children in the tracing group and 14 in the copying group. A special scoring system was used. The learning curves showed negative acceleration. Improvement in tracing 1 series was accompanied by improvement in tracing the second. Improvement in copying showed less transfer. There was little transfer from tracing to copying.

Dashiell (11) compared complete *versus* alternate methods of learning 2 maze habits. The maze was described in an earlier article by Stetson and Dashiell (91). Eight four- to five-year-old kindergarten children were used. The children were divided into 2 groups, 1 learning first 1 pattern and then its reverse, the other learning the 2 patterns by trials on alternate days. The group learning by the complete method showed fewer mean errors in 25 out of 32 trials and shorter mean time in 22 out of 32 trials. Its performance was much more regular, and thus elimination of errors was more rapid.

Mattson (68) has studied the relationship between the complexity of the habit to be acquired and the form of the learning curve in 50 children from 4 yrs.–10 mos. to 6 yrs. of age. Experimental and control groups were matched for sex, chronological age,

I.Q., and maze ability. After an initial four-day practice period, 26 days of practice were given the experimental group followed by a two-month interval of non-practice and an eight-day rest period. Three rolling ball maze patterns of different complexity were used every day, 3 trials each. The practiced subjects were superior on all 3, the superiority increasing with increasing complexity of the problem. The relationship to mental test ratings was slight. The degree of loss in skill was related to the degree of proficiency attained. Forgetting did not proceed more rapidly on the complex than on the simple task.

Beebe (**6**) studied improvement in eye-hand coördination when the factor of horizontal deflection of the field of view by a prism was introduced. Children 4 yrs.–4 mos. to 5 yrs. of age were used. The task was to punch a marble out of a hole within a given time which was controlled by turning off the illumination. Individual differences were marked and variable. Practice effects were observable within 1 series of 10 trials. The deflected series showed increased horizontal error although recovery was fairly rapid.

Two articles give analytical data on the conditioning of micturition. Hull and Hull (**40**) studied the acquisition of bladder control and presented a learning curve for this behavior in 1 child. They presented a simultaneous curve for the acquisition of language, the early stages of which seem to be coincident with a plateau on the curve for bladder control. Scoe (**88**) studied the effect of training upon 36 infants (age range 7 to 16 months) and made comparisons with a large relatively untrained group. His criteria of response were ability to void when placed on the chamber and ability to retain. He concluded that systematic training resulted in an initial period of rapid progress and a later period of slight progress. Gain was generally proportional to regularity of training. Among the infants with no previous training, the younger responded more readily to training on the voiding criterion but not on the retention criterion. Age correlated highly with ability to retain. Retention was interpreted as the more mature process.

Summary

The work on learning is similar in many respects to experimentation in child psychology as a whole. Historically, a transition has taken place from the anecdotal and biographical methods to experimentation which is, in many cases, on a par with work on animals and older individuals. In particular, there has been an increasing

use of the controls important in studies of learning in rapidly growing organisms. Interest has shifted from the tryout of techniques and the achievement type of research to more analytical studies of the learning process.

The more refined researches thus far, however, may be characterized as being samples of many types of problems rather than as units in an integrated program. Although quantitative differences between learning in young children and learning in animals and human adults have been rather consistently demonstrated, certain qualitative differences and similarities have also been in evidence. This is especially true of comparisons between the performance of animals, children, and adults in situations where language and other symbolic processes may function. Present studies are only suggestive with regard to the true significance of the relationships involved. There seems to be a particular need at present for consistent and systematic programs of research on the type of problem in the solution of which a genetic approach has special strategic advantages.

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GUTHRIE, E. R. *The Psychology of Learning.* New York: Harper and Brothers, 1935. Pp. viii+ 258.

Every now and then a book appears which all professional psychologists will wish to read; this is such a book. While the author undoubtedly has his eye on his professional colleagues, it is written with a wider audience in mind. The book is so delightfully written and the fundamental ideas so clearly expressed and illustrated, that less advanced students who may not follow the critical portions in detail will doubtless be persuaded to put the ideas into practice.

The fundamental principle which recurs convincingly throughout the book is that the behavior of the organism is best understood in terms of its past history. Guthrie contends that only association or conditioning theories can use this past history as a source of prediction. More specifically, the form of association theory which is envisaged may be stated as follows: "A combination of stimuli which has accompanied a movement will on its recurrence tend to be followed by that movement" (p. 26).

Association and conditioning are accepted as synonymous terms, but this does not imply that the conditioned reflex is the basis of association. Learning is conditioning by definition, not by discovery; the conditioning principle is merely a blank form which explanations of instances of learning may take. "Pavlov's conditioned salivary reflexes are to be explained in terms of conditioning, but they are not the elementary forms of conditioning on which to base a theory" (p. 68). Although the book makes many contributions toward the interpretation of conditioned response phenomena, it is in no sense a review or exposition of the literature which has grown up as a result of experiments of the type which Pavlov's name suggests. The findings of conditioned response experiments are not basic to the exposition. This is illustrated in a list of 20 "best established generalizations" regarding the conditioned response (pp. 33–36). The inaccuracy of the statements reflects not upon Guthrie's scholarship, but upon his lack of interest in the details of such experiments. If they were important to his views, he would not have handled them so lightly.

The theoretical treatment of problems commonly dealt with in

conditioned response experiments is very stimulating. Most heterodox from the Pavlov point of view is the omission of the unconditioned stimulus as essential to a description of the conditioning process. Association is not between stimuli, but between stimuli and movements. A second heterodoxy is the denial of experimental extinction as a fundamental property of the conditioned response. Inhibitory conditioning (which includes extinction) is explained in the same terms as ordinary conditioning; the behavior that occurs is the behavior that is conditioned. Generalization (the tendency for responses to occur to stimuli which have never accompanied them) is explained ingeniously in terms of movement-produced stimuli. The true conditioner is probably not the presented stimulus, but sequences of proprioceptive stimuli aroused by the elicited movements. Since the proprioceptive consequences of varying but similar stimuli may furnish identical internal cues, the conditioned response may be elicited by a seemingly novel stimulus. This very plausible theory awaits experimental confirmation. Like the other theories, this is stated in definite terms, so that those who disagree with Guthrie may go into the laboratory and find evidence which bears upon his assertions.

The principle of searching for the cues to behavior in the history of the organism is applied to a great range of phenomena. In the course of dealing with practical problems many familiar controversies are paraded and skillfully dealt with. The apparent success of frequency as a factor in learning is an artifact due to the enlistment of more conditioning cues with repetition. The alienation of these cues accounts for forgetting. The facts embraced in Dunlap's Beta hypothesis are explained through knowledge of cues and their deliberate side-tracking. Emotional reinforcement aids learning by furnishing additional internal stimuli to serve as conditioners. Lashley's findings that definite brain areas have little specific effect on habits may be predicted through the principle that many cues are operating in an established habit; brain destruction will doubtless alter movement, but many cues persist to give stability to the habit. The range of problems treated includes perception and thought.

The occasional sword-crossing with Humphrey, Pavlov, Thorndike, Tolman, Wheeler, and other systematic writers, is done carefully and tolerantly. Facts which are true cannot be contradictory; theorists have a right to be interested in predicting facts of different orders. Teleological laws have a respectable place in science. Guthrie

has none of the " you-must-not-say " attitude characteristic of earlier behaviorism.

The chief tenets of the book are more or less plausible dogmas, which one may criticize freely because the author has provided his own instruments of criticism. Good rules, he says, must be based upon observation, and verified by observation. Three fundamental rules seem to the reviewer not to meet these qualifications. The first is the dogma that learning is permanent, unless it is altered by new learning. This is derived from very limited observations, and it is not susceptible to observational proof or disproof. The second is that simultaneity is the basic condition of association. The best known conditioning experiment originating in Guthrie's laboratory is that of Wolfle, which showed simultaneity to be unfavorable for conditioning. To discount these facts, Guthrie falls into Pavlov's habit of postulating traces not observed in the experiments. Certainly an equally good argument could be made for immediate succession. Postulating unobservable movements differs little logically from postulating brain processes (a tendency which Guthrie rightly deplores). The third dogma is that recency is a fundamental principle, and that frequency is not. Modifications due to frequency are attributed to the enlistment of more cues with repetition. If one grants that the most recent experience is the one from which cues have not yet been alienated, the effect of recency can be explained on the same grounds as the effect of frequency. The observable facts favor recency no more than they favor frequency.

The movements which occur during conditioning, according to Guthrie's fundamental proposition, are the ones which should be evoked by the conditioned stimulus. Confronted by the facts, he recognizes that the responses to the conditioned stimulus are often different from those during conditioning, *e.g.*, the chewing movements when an animal is fed are different from those aroused by a bell or light. This supplementation of the simple formulation (by recognizing a difference between conditioned and unconditioned responses) is essential to his theory of extinction (p. 79). It is unfortunate that the necessary additions to and corrections of the original statement of the conditioning principle have not been accepted as formal amendments to it. The nature of the conditioned response in relation to the unconditioned response is one of the most baffling questions regarding conditioning, and premature statements of the relationship are a source of great confusion.

Guthrie has written a book which will be warmly received by

American psychologists because it is well within our traditions. The clarity of the fundamental presuppositions, while involving an oversimplification which Guthrie recognizes, makes them stimulating as reference points for both discussion and experimentation. There are enough precautions that even the beginning student will not be misled into believing that all is settled.

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FLETCHER, J. M. *Psychology in Education.* New York: Doubleday Doran and Company, 1934. Pp. xx+524.

There are, perhaps, two things which distinguish this book from some of the others that might be used in the average course in educational psychology. The first is to be found in its central theme, *viz.*, that a fairly sharp distinction should be drawn between the processes of psychological intake and the processes of psychological output, for the psychologist, in his approach to the field of teaching, and in order to fulfill his mission, must examine not only the laws of learning but the nature and significance of creative thinking as well. After an introductory chapter which is both historical and critical, the first step in support of the above distinction is taken by a rejection of the more formal concepts of original nature and instinct in favor of pervasive urges toward "self-realization and fulfillment" (p. 67). Chapter III criticizes the mentalist and the behaviorist, the first, because his concept of mind is too passive, and both the first and the second, because they are too atomistic. In order further to establish the activity of consciousness as opposed to its passivity, the author uses the theory of lapsed intelligence (p. 92) and a theory of the way in which the degree of the inheritance of acquired characters may change in phylogenetic history (p. 93). After a conventional chapter on intelligence (Chapter IV) the author turns to the laws of learning which deal directly with mental acquisition or intake. The remaining chapters of Part I consider the curriculum, the feelings and the emotions, and mental hygiene. It is argued that the curriculum should be instrumental and creative rather than passive and mechanical. The same inflection is given to the development of the feelings and emotions. The mental hygiene movement, too, should lend itself to the development of persons who have sufficient means of expression as well as of impression.

The central theme of the volume is expanded in Part II, where a distinction is drawn between reflective thinking and creative think-

ing in terms of ten criteria (pp. 369–378). The common feature in all of these criteria is furnished by the argument that reflective thinking is too passive. After a digression on a theory of knowledge (knowing conceived as identification) which is used as a basis for a new methodology of learning, there are three chapters on the creative aspects of personality. The author finds in abnormal psychology, in the operations of the genius, and in a suggestive study of the relations between drugs and intellectual productivity, further support for his thesis that the educative process should lead to increased measures of psychological output. The last chapter is a less satisfying series of comments on education as a social process.

The second feature of this book is suggested by the announced intention of the author to present a study which, while presupposing a course in psychology, will not simply review material that has already been covered. This goal has been reached, in part, by reducing the direct appeal to current experimentation to a minimum and, in part, by drawing generously on comments and seasoned judgments about the general meaning of the several varieties of psychology in the art of teaching. The author is obviously impressed by the great difficulty of writing an impersonal account of the education of persons.

Every student of educational psychology must, of course, feel as keenly as the present author does the marked discrepancy between strictly laboratory studies in the field of teaching, on the one hand, and those seasoned judgments and evaluations which ought to modify all applications of laboratory facts, on the other. It is easy, however, to let oneself go astray when one remarks this difference and when one attempts to make up for the difference by ranging, as Fletcher does, from the *New York Times* and the *Saturday Review of Literature* to Walt Whitman, Arnold, and Stevenson. It stands to the author's credit that he has been able to forage widely outside of the experimental tradition and yet keep his comments and judgments well within the range of probability.

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FREEMAN, GRAYDON LAVERNE. *Introduction to Physiological Psychology.* New York: The Ronald Press Company, 1934. Pp. xvii+579.

This book is an important contribution to physiological psychology in the way of organization and systematization. A con-

siderable amount of material has been treated that had not previously been brought together.

The author, as he points out in the preface, has departed from the lines of emphasis that characterized former treatments. Sensory functions are sketched briefly, while nervous and motor functions are discussed at length. The treatment is intended as introductory rather than comprehensive. As the author states, it "makes no pretense to exhaustive scholarship upon any of the topics covered but seeks only to relate the highlights of each one of these into a consistent whole" (p. vi).

The book is divided into four parts. The first part, "Basic Neural Mechanisms in Behavior", begins with the problem of organismic pattern, and then passes to a treatment of nerves and nervous activity, receptors, effectors, and adjustor mechanisms. The second part, "The Structuro-functional Organization of Neural Mechanisms," is largely a treatment of the anatomy of the nervous system. The third part, "The Integrative Action of Neural Mechanisms", includes spinal and cortical integration, facilitation and inhibition, and related topics. The fourth part, "Neural Mechanisms and Variable Behavior", discusses the subjects of motivation, sets, learning, intelligence, temperament, and "decrement, fatigue and oscillation".

In the earlier sections of the book there are a great many errors, indicating evidently that the preparation of this part was unduly hurried. Most of the errors are minor in character, and need no special mention. Others, such as the following, may confuse the student. The statement of Müller's doctrine of specific energy of nerves (pp. 59–60) bears little resemblance to the original. The author presents a modern view, without making it clear that in many respects it is the contrary of that of Müller. The statement of the Weber-Fechner law (p. 61), also, is not the usual one. This law is given as the law that "equivalent increments in stimulus intensity are not equally effective upon the organism", and the significance of the word "equivalent" is not made clear. The treatment of the receptors is generally unsatisfactory.

In several places the use of terms is confusing or incorrect. The apparatus used by Tashiro to study the production of carbon dioxide by nerves he called a *biometer*, not a *barometer*, as stated on pp. 17 and 36. The word *acousticae* (should be *acusticae*) is an adjectival form, and cannot properly be used as a class name for the sensory endings of the non-auditory labyrinth (pp. 66–67). The term

maculae cristae (p. 66) should be *maculae acusticae*. The part labeled "otoliths" in Fig. 21, which portrays the crista acustica, is probably intended as the cupula. Otoliths are found in the maculae, but there is no good reason to believe that they occur in the cristae. Moreover, there is recent work which shows very definitely that the cupula itself is an artifact. The term *folliform* (p. 84) for a type of papilla on the tongue is new to the reviewer. The upper limit of hearing is nearer 20,000 than 40,000 d.v., as stated on p. 89. The statement on p. 114 that "a nerve and muscle are said to be *heterochronous* if the ratio of their chronaxies reaches a value of one to two" should read ". . . a value of one half".

Misspellings are fairly common in the first part of the book, but not in the remaining parts. There are a good many mistakes in the references, and an occasional use of "*op. cit.*" where the "*op.*" cannot be found. Somewhat disturbing is the manner of citing other works. There are many passages in small type, introduced in such a way as to be taken for quotations. They are not quotations in a strict sense, however. They follow the original closely for the most part, but in places have been "edited" by omissions, substitutions, and changes of sentence structure. So far as the reviewer has found, however, these changes do not alter the meaning of the original passages.

An exception must be taken to the statement in the preface that physiological psychology is "a field which has not been plowed over thoroughly for more than two decades", in view of the extensive treatise of Troland, *The Principles of Psychophysiology*, which has appeared since 1929.

Certainly the most important section of the book is Part IV on neural mechanisms and variable behavior. And perhaps the most significant feature of this section is the attempt in Chapter 23 to account for predispositions or determining tendencies in terms of what is called the "postural substrate", the "general neuromuscular background". In the concluding chapters the author presents a scholarly and well-considered discussion of higher organic functions from the motor point of view.

In general, the treatment is direct and free of controversy. In connection with disputed matters, the author presents the different views fairly and sympathetically, and concludes usually with a word of caution and a suggestion of the need of further investigation. When he does take sides, his choice is a conservative one. The book

is worthy of a careful examination by everyone with systematic interests in physiological psychology.

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HARTSHORNE, CHARLES. *The Philosophy and Psychology of Sensation.* Chicago: University of Chicago Press, 1934. Pp. xiv+288.

The author of this book is philosophically an absolutist and a totalitarian. His absolutistic belief about the universe is that it is continuous or dimensional instead of discontinuous and atomistic. As a totalitarian Hartshorne believes that the universe is not only psychic (he describes himself as a panpsychist) but ultimately affective. For him, *Gefühl ist alles.* His preoccupation with the psychology of sensation is to establish what he calls the theory of the *affective continuum.* This theory may be formulated in the proposition that the stuff of which the entire content of consciousness is composed is affective tone (p. 7).

The argument of the book takes the form of an attack upon the Helmholtzian doctrine that the different modes of sensory qualities are irreducibly heterogeneous. For the atomic and separatist theory Hartshorne wants to substitute one of dimensions. The grays are not molecular combinations of white and black atoms, but rather points on a line. Grays are the intermediate values of a single variable, of which the extremes are black and white. The same thing is true for the chromatic series. In this respect the author aligns himself with Goethe rather than with Newton. The further development of this dimensional idea is that colors, sounds, and other sensation qualities are degrees of a single continuum.

But not only are sensations all continuous; there is no fundamental differentiation between them and feelings. For example, for the author there are only four real primary colors: scarlet (warmth-activity), buttercup yellow (brightness and joyfulness), sea-green (cold-passivity), and violet (dullness and sorrowfulness). The joyfulness or gaiety of yellow, it must be understood, is the yellowness of yellow (p. 7). The principle behind all this is the essential unity of the mind and its contents. In being aware of a color one is at the same time feeling a mood, while both feeling and awareness are the same as the color and the feeling quality.

Hartshorne claims to find a basis for his continuity view in the experimental findings of psychologists, although he really relies as

much upon the evidence of word-usage (for example, pp. 58, 66, 68, 73, 77, 85, 88, 202, 233). Of course he rejects the evidence of word-usage when presented by Brentano (p. 139), but is just as selective in experimental material. For example, Bichowsky's and Nafe's experiments are acceptable because the former is presumed to show how feelings become objectified as sensations, while the latter is taken to break down the distinction between feelings and sensations. On the other hand, an experiment of Burnett and Dallenbach on the experience of heat is not so agreeable to the author unless he can reinterpret it to show the comparability of different sensory modes.

It would be a mistake to dismiss this attractively made volume as mere philosophical speculation, for it has the merit of showing how much philosophical speculation there is in the psychology of sensation. Nor can its value be mitigated as an excellent illustration of how careful experimental work can be assimilated to and made evidence for some sort of philosophical speculation.

One may, however, complain that this little book does not give any indication that in recent years psychology has reached so high an objective peak that it is now possible to describe psychological phenomena without dissipating them in a darkness in which all cats are gray. What shall we do when a subject describes a temperature experience as a large, dense, gray square with a strip of gray smoke at the top, as a protocol of Burnett and Dallenbach indicates one subject did? Do we have to interpret this to mean that warmth and cold and gray squares and smoke are all at bottom psychic feelings? So far as scientific psychology—which investigates the concrete behavior of observable things—is concerned, the response to a warm or cold object certainly can be satisfactorily described as an interaction between an organism and an object with all its properties, quite in the same manner that the interaction between hydrogen sulphate and sodium chloride is described by a chemist.

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GILLILAND, A. R. *Genetic Psychology.* New York: The Ronald Press Company, 1933. Pp. xii+351.

The evolutionary point of view and the application of the genetic method have been familiar since Lamarck and common to all the sciences since Darwin. In psychology likewise, the brilliant speculations of Spencer were a preface to the formal acceptance of an

evolutionary standpoint since William James. It is therefore peculiar that although the use of the phylogenetic approach in animal psychology, and the ontogenetic approach in child psychology have yielded many volumes, no modern work in English has attempted to cover the entire field of psychogenesis. This is the more remarkable since Romanes had offered early and suggestive examples in his works on *Mental Evolution in Animals* and *Mental Evolution in Man*.

The present volume is an attempt to survey the entire field of genetic psychology, in which knowledge has become far more detailed and extensive since Romanes' time, while a more critical spirit has rendered much of the older data unserviceable. Under such circumstances the author states frankly that his aim is to present "a broad summary of the general field of genetic psychology, rather than an intensive study of any single feature of it" (p. 7). In simple and non-technical language he sketches the evolution of behavior and the structures upon which it most intimately depends from protozoan to adult man. Concurrently he traces within the various phyla the processes of development from infancy to maturity.

In developing his subject, Professor Gilliland is gentle to vitalists and Gestalt psychologists, but inclines to a mechanistic point of view as more promising of "constructive results" (p. 27). With this exception he is singularly free from psychological dogmas, prejudices, or even convictions. He refuses to take a definite stand on debatable topics such as the nature of instinct, the classification of the emotions, or the localization of functions in the brain. The standpoint is that of an eclectic or "middle grounder" in genetic psychology, so that this book could be used with equal satisfaction by adherents of every school.

It may seem to many that a certain inequality of treatment pervades this work, or at least a large part of it. Thus after an excellent chapter on "The Nature of Life", the discussions of the vertebrate and invertebrate series seem too brief in comparison with the importance of the material and the purpose of the work. Moreover, there is an unfortunate misquotation at a crucial point in a long passage cited from Holmes (p. 72). In a criticism of experimental methods in the study of animals Holmes says: "We may be guided on the one hand by analogy with ourselves, which leads us to infer that actions similar to our own are accompanied by similar mental states; and by the law of parsimony on the other, which forbids us to assume the existence of higher mental qualities if the phenomena

can be explained in terms of simpler mental processes." [1] In the passage as cited " bids " is substituted for " forbids " and two other minor errors occur.

The chapters on inheritance, prenatal development, early postnatal phenomena, physical growth, and the development of skill are full of well selected material, while the discussion of play departs from the genetic method on grounds not very convincing to an evolutionist. An ingenious extension of Robinson's " Compensatory Theory " of play is suggested.

The chapter on " Music and Art " is probably the least satisfactory in the work. The distinction between music and the other arts is artificial and useless. Many of the author's special conclusions are also questionable. It is far from certain that drawing is about the only form of primitive or prehistoric art. Ancient Egyptian art, when all of its forms are considered, does not rank low even when compared with the art of Greece. As to music, there is no adequate treatment of the origin of this art although Darwin, Noire, Bucher, Wallaschek, and Stumpf, to name but a few, have had considerable to say on this question, and one is astonished to learn that Pythagoras " got many of his ideas about music from his long studies in Alexandria " (p. 186).

The remaining chapters dealing with the genetic psychology of intelligence, perception, language, memory, thinking, the emotions, adolescence, personality, character, and health and disease, in the order stated, are also somewhat unequal. The first four are very good, the discussion of language being of particular excellence. The final chapters evoke an impression of their provisional character and awaken doubt as to the interpretation of many special questions. For example, when the author states that " It is not difficult to realize that the whole development of romanticism, both in practice and in literature and art, as well as the institution of the home, are largely built upon the normal expression of the sex instinct " (p. 313), one wonders why he limits his statement to romanticism. In general it would seem that the contributions of psychoanalysis and allied schools to genetic psychology are treated with undue neglect. The alleged data of the analysts at least merit consideration. Again when the author writes of taboos as the outcome of tribal councils (p. 333) he seems to imply a more conscious and deliberate origin of taboos than the facts of primitive culture justify.

[1] Holmes, S. J., *The Evolution of Animal Intelligence.* New York: Holt, 1911. Pp. 234.

Few will agree that social intelligence, personal appearance, morality, emotionality, and aggressiveness (p. 323) form a satisfactory list of personality traits. The terms are highly relative, overlap in some degree, and are but in part psychological.

Finally the author does not seem clear as to the nature of mental and emotional diseases. "Mental disease may be looked upon as the lack of mentality or intelligence" (p. 345). Is mental disease then identical with feeblemindedness? Are emotional diseases entirely non-mental?

The preceding criticisms do not imply that Professor Gilliland has not produced an excellent compendium of the facts of genetic psychology and a pioneer textbook welcome to both teachers and students. The direct style, relatively non-technical language, and adequate bibliographical references, make of it a good supplementary reading in introductory courses, while the existence of such a text should encourage the organization of many new courses in genetic psychology.

CHARLES M. DISERENS.

University of Cincinnati.

GRIFFITH, COLEMAN R. *Introduction to Applied Psychology.* New York: The Macmillan Company, 1934. Pp. xv+679.

This, the most comprehensive of the books on Applied Psychology, consists of eight parts and forty chapters. It is aimed at the university student and begins with various problems of student life, such as driving an automobile, participating in athletics, sleep, vocational guidance, and how to study. The most original of these early chapters is that on athletics, which draws upon the author's own research work.

The second part deals with social problems, such as social and group behavior, leadership, imitation, racial and sex differences. Some parts of this section do not seem especially germane to the rest of the discussion, as, for example, the part dealing with the group mind, or factors involved in inventions. Part III deals with law, including causes of crime, diagnosis of guilt, testimony, and punishment. The discussion of crime detection impresses the reviewer as somewhat too abstract and fails to note the rather successful work of such people as Larson. With reference to punishment, there seems to be too little mention of its deterrent effect. Part IV deals with medicine and recounts the conventional psychological ailments, and various methods of treating them. This is one

of the best sections of the book. Part V takes up education, with chapters on its social value, age differences, intelligence, psychology of teaching, and transfer of training.

The sixth section deals with industry and commerce and after a rather lengthy introduction gets down to accident proneness, industrial efficiency, advertising, selling, and personnel selection. In the advertising chapter the author does little more than state some of the problems but admits that one could discuss practically all aspects of psychology in this connection. A minor omission in the personnel discussion is the possibility of trade tests. In the seventh section we have the psychology of art with some discussion of the emotions and feelings which are involved in the esthetic attitude, the possibility of hereditary factors in artistic ability, and some of the efforts at measuring such things as musical talent. The last part goes back to some of the fundamentals of psychology which ordinarily are omitted from a book like the present. The author does make frequent forward references to these last five chapters, where he discusses attention, emotion, personality, heredity *vs.* environment, laws of learning, and methods of psychological experiment. The final chapter discusses general problems of human fellowship and tries to make a case for applied psychology as one factor that will retard social decline.

The reviewer has no adverse criticism as to the actual content. He would not minimize hereditary and so-called instinctive factors to quite the extent that it is done in the text (the effort is made, for instance, to show that competition and imitation as motives are largely acquired). The author also seems to lean a little too heavily in the Freudian direction, although he does give a good account of Freudian methods and results. There is occasionally, however, what seems to be unwise emphasis on points that are rather remotely related to the discussion at the expense of being unduly brief on many practical considerations. For instance, there is only a page and a half of discussion on monotony, whereas in introducing the topic of industrial psychology over twice that much space is devoted to the question of determinism and still more to distinguishing pure and applied psychology and defining psychotechnics. The author tries to include about everything that might be remotely construed as applied psychology; for instance, he includes many things that are found only in a text on social psychology. He also attempts to include a good deal of the general field and when he runs into some fundamental concept is apt to pursue it quite extensively.

The book is well annotated, and would serve as a valuable bibliography to one who is running down further material on the subject. The topics are discussed under numerous italicized headings which make for clarity of the work. The frequency of these headings is admirable, although some of them are perhaps a trifle too catchy, such as "yellow streak", "jinx", or "lie detector".

The aspect of the book which the reviewer dislikes the most is the fact that it takes each chapter considerable time to get under way. There is always a rather long section labeled "introduction" which states the problem and attempts to tie it in with the rest of the discussion, but often spends time in this way that might well be spent in giving more details on some of the practical topics appearing in the body of the chapter. The book is not as interestingly written as some others in this general field. While effort is made to "jazz" the headings, the text itself does not participate in this tendency. It is not meant that the work is dull but it lacks that intriguing something that might well be a part of a book on applied psychology. It may be that the reviewer's impression is due somewhat to the introductory sections mentioned above. The instructor using the text will probably select judiciously. It is doubtful if the average class would care to go through the thing from cover to cover.

The book is a distinct contribution to the field, especially by virtue of its comprehensiveness. It is written rather definitely at the college level. The reviewer suspects that it will be quite generally and successfully used as a college text but will not be read very widely outside of the academic field.

HAROLD E. BURTT.

Ohio State University.

FREEMAN, FRANK S. *Individual Differences.* New York: Henry Holt and Company, 1934. Pp. 355.

The fairest appraisal of a book's merit is a statement of the extent to which that book accomplishes the author's avowed purpose. This book was intended to function at an intermediate level. The student who has completed the elementary course in psychology ought to have no difficulty in following the author's treatment of individual differences. Numerous illustrations in the earlier chapters serve to make the book appealing. The printing is good and the paper adequate.

The first chapter traces the history of the study of individual differences since Plato's *Republic.* This is done in an interesting

way without falling back on the sad story of the astronomer's assistant who lost his position because his personal equation differed from that of his chief.

The treatment of such controversial topics as heredity *vs.* environment and sex and race differences is non-partisan and cautious. In general the material is well selected, although not entirely comprehensive. For example, the important experiment of Woodrow on the rate of learning in normal and feebleminded children of the same mental age is not included. When the facts are clear the author takes a firm and uncompromising stand—as in the case of so-called "types". In most instances the author has shown a fine appreciation of the dangers of superficial interpretation of psychological data. One noteworthy exception to this is the extended treatment of the experiment of Reed on the effects of practice on individual differences. The failure of the author to indicate the disturbing effect of the fact that chance errors in measuring initial ability correlate negatively with gain—a source of error inherent in Reed's experiment—is serious.

The reviewer is not inclined to agree with the author on the function of statistical methods in this field. "In this book there is not a chapter devoted to statistical method. I believe there is no justification for the inclusion of such a chapter in a book dealing with a subject for which statistical methods are tools and not ends in themselves." In the opinion of the reviewer statistics are far more than tools, constituting as they do in certain instances the very *language* in which the problem is stated. The recent contributions to factorial analysis, along with the earlier work of Spearman and his students, have not been treated in this book. Nor could such studies be treated in a non-statistical fashion.

In general the book succeeds in what it sets out to do, namely, to acquaint the student with the less statistical aspects of the problems and findings in the field of individual differences.

FLOYD L. RUCH.

University of Illinois.

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NOTES AND NEWS

Professor Harvey A. Carr, chairman of the department of psychology at the University of Chicago, has been on leave during the fall and winter quarters. The leave has been spent in completing the manuscript of a book on *Space Perception,* and in traveling in the Southwest.

Dr. Madison Bentley, professor of psychology at Cornell University, spent the first semester on leave in California, and has returned to Cornell for the second semester.

DR. LEONARD CARMICHAEL, professor of psychology at Brown University, has been appointed lecturer in psychology at Harvard University for the second semester.

DR. JOHN F. DASHIELL, head of the department of psychology, and five other members of the faculty at the University of North Carolina have been promoted to the rank of Kenan professors. The appointments are made possible by the Kenan Professorship Endowment, a fund which was bequeathed to the university in 1916 by the will of the late Mary Lilly Kenan Bingham.

AMONG the outside speakers who have addressed the colloquium of the psychology department at Brown University, made up of graduate students and members of the staff, during the first semester, are Professor Herbert S. Langfeld of Princeton University, Professor Edwin G. Boring of Harvard University, Dr. J. G. Dusser de Barenne of Yale University, Dr. Edna Heidbreder of Wellesley College, and Dr. Edward H. Kemp of Clark University.

PROFESSOR KURT LEWIN, formerly of the University of Berlin and lately of Stanford University and Cornell University, will be in residence during 1935–1936 in the Child Welfare Research Station of the University of Iowa as visiting professor of child psychology. He will offer seminar work in his field to advanced students and will continue certain researches in psychodynamics. Professor Lewin will be assisted in the Station by several post-doctorate fellows supported by a special grant from a foundation.

PROFESSOR WILHELM STERN of Hamburg has been appointed to a visiting professorship at the University of North Carolina for this year.

DR. HAROLD E. BURTT, professor of industrial psychology at Ohio State University, is broadcasting a course on legal psychology directly from the classroom through Station WOSU. Through the use of a special auxiliary condenser microphone, students' questions and discussions are broadcast as well as the lectures.

DR. HAROLD A. EDGERTON, assistant professor of psychology at Ohio State University, is on leave of absence for the first six months of 1935, and is spending his leave working on occupational research for the United States Department of Labor in Washington, D. C.

DR. MERRILL F. ROFF has been appointed instructor in the department of psychology at Indiana University. Dr. Roff has been

engaged in research work in the department of psychology at the University of Chicago.

Dr. George F. Arps, chairman of the department of psychology at Ohio State University, delivered the chief address at the North Carolina College Conference at Greensboro, North Carolina, November 8, 1934.

Dr. Horace B. English of Ohio State University will be professor of educational psychology on the summer session faculty at the University of Nebraska this year.

Dr. Herbert A. Toops, professor of psychology at Ohio State University, is devising a uniform college entrance blank for the use of the Ohio colleges, as part of the program of the Ohio College Association.

Dr. George Plant Horton, formerly of Princeton University, has accepted an appointment as instructor in the department of psychology at the University of Washington, Seattle, Washington.

A Congress of General Semantics was held at Ellensburg, Washington, March 1 and 2, under the auspices of the Washington State Normal School at Ellensburg. Papers were read and panel and open discussions held on the theoretical, educational, and experimental phases of general semantics. Among those on the program were Count Alfred Korzybski, Professor O. L. Reiser of the University of Pittsburgh, and Professor Wm. E. Ritter and Professor C. E. Rugh, both of the University of California.

Mr. Carl Pfaffmann, who graduated with honors in psychology from Brown University in 1933 and who has been a graduate student in psychology during the last two years at Brown, has just been appointed to a Rhodes Scholarship from the New England district. Mr. Pfaffmann plans to work on the physiology of the senses and the nervous system at Oxford.

Dr. Joseph W. Hawthorne, instructor in psychology at Washington University, St. Louis, Missouri, resigned on December 1, 1934, to take a position in Los Angeles. Miss Winifred Magsdick has been appointed temporarily to take Dr. Hawthorne's place.